LEVEL II

APRO 709-3

FINAL

DETERMINING AND FORECASTING SAVINGS FROM COMPETING PREVIOUSLY SOLE SOURCE/NONCOMPETITIVE CONTRACTS

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ARMY PROCUREMENT RESEARCH OFFICE

U.S. ARMY LOGISTICS MANAGEMENT CENTER
FORT LEE, VIRGINIA 23801

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DETERMINING AND FORECASTING SAVINGS FROM COMPETING PREVIOUSLY SOLE SOURCE/NONCOMPETITIVE CONTRACTS

by

Edward T. Lovett

Monte G. Norton

US ARMY PROCUREMENT RESEARCH OFFICE
US Army Logistics Management Center
Fort Lee, Virginia 23801

EXECUTIVE SUMMARY

A. BACKGROUND. Within the defense market, it is difficult to isolate, identify and quantify the impact of competition on acquisition costs. Traditionally, a 25% reduction is expected, but there is no empirical support for such expectation. Actually the Department of Defense has no firm basis for deciding when to introduce competition or even if competition should be introduced. When the value of competition cannot be measured with a reasonable degree of confidence, defense of budgetary estimates and the development of a good acquisition strategy is exceedingly difficult, if not impossible.

B. STUDY OBJECTIVES. The objectives of this study are to: (i) develop a methodology to estimate the net savings achieved due to competition, (ii) further develop the methodology to forecast the net savings expected from introducing competition into the procurement of future major weapon systems, (iii) furnish an organized data basis to support the net savings methodologies.

C. STUDY APPROACH. The approach taken to achieve these objectives includes a thorough investigation of the procurement histories of sixteen items which were originally produced on a sole source basis and were later competed, the identification and analysis of factors explaining savings due to competition, and the synthesis of these factors into workable methodologies.

D. SUMMARY AND CONCLUSIONS. The savings achieved by introducing competition into the production of weapons systems can be reasonably estimated. Of the sixteen items analyzed, five showed a loss due to competition. Savings for the sixteen items averaged 10.8 percent. The forecasted savings methodology (FSM), which was developed from the analysis of the sixteen systems, is a useful tool which provides an estimate of the expected savings, or loss, from introducing competition as well as an analysis of the qualitative factors influencing competition. A test of the FSM should be conducted.

RE: Classified references, distribution unlimited-
No change per Mr. R. Brannon, ALMC/APRO

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CHAPTER I

INTRODUCTION

A. BACKGROUND.

Within the defense market, it is difficult to isolate, identify, and quantify the impact of competition on acquisition costs. Traditionally, a 25% reduction is expected, but there is no empirical support for such expectation. Actually the Department of Defense has no firm basis for deciding when to introduce competition or even if competition should be introduced. When the value of competition cannot be measured with a reasonable degree of confidence, defense of budgetary estimates and the development of a good acquisition strategy is exceedingly difficult, if not impossible.

This report is an unclassified compilation of the work of the Army Procurement Research Office in the area of competition. It incorporates material from a study by Tecolote Research, Inc., details of which are not here included.[1]

B. STUDY OBJECTIVES.

The objectives of this study were:

1. Develop a methodology to estimate the net savings achieved due to competition.

2. Further develop the methodology to forecast the net savings expected from introducing competition into the procurement of future weapon systems.

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[1] A. J. Kluge and R. R. Liebermann, "Analysis of Competitive Procurements," Tecolote Research, Inc., 5266 Hollister Ave., Santa Barbara, California 93111 TM-93, August 1978. (FOUO)

3. Furnish an organized data base to support the net savings methodologies.

The net savings methodologies were developed for application on missile and electronics systems in general. Included in the forecasted savings methodology is the criteria that must be met before efforts should be made to introduce competition into the acquisition of a specific system.

C. DEFINITIONS.

CONTRACT PRICE OR PRICE: the cost of an item to the Government. It includes all costs to produce the item, both direct and indirect, plus profit.

COST: the total expenses incurred in order to produce an item, both direct costs and an appropriate share of indirect costs.

DIRECT COST: any cost that is specifically identified with a particular final cost objective.

INDIRECT COST OR OVERHEAD: any cost not directly identified with two or more final cost objectives or with at least one intermediate cost objective.

NON-RECURRING COSTS: one-time costs such as initial production facilities, special acceptance and inspection equipment, and other "start-up" costs required to produce an item.

RECURRING COSTS: those costs, excluding non-recurring costs, necessary for production of an item. Manufacturing labor costs and the cost of materials consumed in production of the item are examples.

RECURRING PRICE: recurring cost, including G&A, plus profit.

D. SCOPE.

The analysis in this report is based on a total of sixteen systems/items, ten of which were studied by APRO. The remaining six items were studied by Tecolote Research, Inc., (TRI), and are described in detail in their report TM-93, "Analysis of Competitive Procurements."[2] While the data from TRI's report are used in this report, the detailed analysis of the individual items will not be repeated. The distribution of items is recapitulated below.

ORGANIZATION	SYSTEM/ITEM ANALYZED
APRO	TOW Missile TOW Launcher DRAGON Round DRAGON Tracker SHILLELAGH Missile FAAR Radar FAAR TADDS PRC-77 Radio ARC-131 Radio UPM-98 Test Set
TRI	SHRIKE Missile SIDEWINDER Missiles AIM-9B GCG AIM-9D/GGCG Standard Missile BULLPUP AGM-12B Missile MARK 46 Torpedo

[2] Ibid.

E. STUDY APPROACH AND RESEARCH METHODS.

The approach employed to accomplish the above objectives began with a thorough investigation of sixteen items which were originally produced on a sole source basis and were later competed. This included searching through contract files, cost reports, progress briefings, technical data packages, pertinent studies and other related information. The investigation also included interviews with available Government personnel who were knowledgeable of the circumstances surrounding major milestones and decision points throughout the procurement history. Contractor personnel were interviewed to define the business and financial environments at the time of competition. Financial reports, audit reports, and pre-award surveys were also reviewed, when available, to assist in this area. A comprehensive search for competition related literature was made of sources within the Federal Government, and the business and academic communities.

Factors explaining the actual net savings due to competition were identified and analyzed for the extent of influence. Those quantifiable were isolated and used to develop the estimated and forecasted net savings methodologies. They were also recorded and retained as part of the supporting data base. Those influencing factors that were not as easily quantifiable were likewise recorded and retained as part of the data base and were also analyzed as to how their influence could be included in the net savings forecasting methodology.

The estimated savings methodology is based upon a simple cost estimating analysis model using commonly accepted accounting procedures. Net savings are calculated by determining the pertinent cost factors and making adjustments for inflation and learning. The forecasted savings methodology is considerably more complex since it includes an analysis of both qualitative and quantitative factors.

The methodology for forecasting net savings incorporates a regression model to forecast the unit price of the system after the first competitive award. Additional quantifiable factors, including those in the estimated savings methodology, are incorporated to develop the complete set of factors for determining expected net savings from competition. The net savings figure that results from this forecasting model is complemented by an analysis of the qualitative factors by having expert procurement personnel weight them relative to one another and assign subjective scores on a scalar basis which results in a "competition index". This index is then compared with other systems similarly analyzed but already competed to determine if the qualitative factors encourage competition.

The services of Richard A. Scott, Ph.D., CPA, Associate Professor of Accounting, Virginia Commonwealth University, and James R. Marchand, Ph.D., Assistant Professor of Economics, Virginia Commonwealth University, were utilized in the literature search.

F. METHODOLOGY ASSUMPTIONS.

A few assumptions were necessarily made during the development of the estimated savings methodology and the forecasted savings methodology. They were necessary to develop general methodologies that were relatively simple to apply and yet produced reliable results considering the quality of existing data bases and the cost analysis state-of-the art. If the information available on other weapons systems under study is such that different assumptions are warranted, the methodologies should be adjusted accordingly. They are meant to be general guidelines, not an inflexible set of rules. Additional assumptions were made during the application of the methodologies because of the circumstances in the systems being reviewed. These assumptions are described as they occur throughout the report.

CHAPTER II

ESTIMATED SAVINGS METHODOLOGY

A. INTRODUCTION.

It is important to know how much money was saved due to competition for two reasons. One reason is to determine if the investment in engendering competition has been recouped. The second reason is the need to build a good data base on which to base future decisions regarding competition. While it is virtually impossible to determine exactly what savings were achieved due to competition, the savings can be estimated with a reasonable degree of accuracy. The methodology contained in this chapter is basically an accounting model with savings debits and savings credits. In addition to hardware costs, it takes into consideration non-recurring and start-up costs, learning, inflation, and discounting.

Ideally, the procurement of the system under study should be completed. This allows one to determine total quantities procured and actual costs, or prices paid, rather than estimated quantities and estimated costs or prices. The methodology does not address Government administrative costs due to competition. These costs should be taken into consideration in each analysis. Some of the possible Government administrative costs are incurred in the following areas:

1. Preaward Phase.
    a. Preparation of solicitation.
    b. Preparation of additional copies of TDP.
    c. Evaluation of offers.

d. Negotiation costs.

e. Preparation of an additional contract.

f. Additional audit and preaward survey costs.

g. Dual Should Cost studies.

2. Post Award Phase.

a. Extra testing costs.

b. Contract administration costs.

c. TDY to two contractors.

d. Two sets of software reports.

B. <u>ESTIMATED SAVINGS METHODOLOGY</u>.

The methodology developed to provide an estimate of savings achieved is summarized by the flow chart in Figure 2-1. The steps are structured as general guidelines and are not an inflexible set of rules. If the circumstances of a weapons system under study require different assumptions to produce realistic results, the methodology should be adjusted accordingly. The analyst's good judgment should certainly take precedence.

There are seven basic steps to complete the methodology. These are described in detail as follows.

STEP 1. <u>Collect Available Cost and Quantity Data</u>

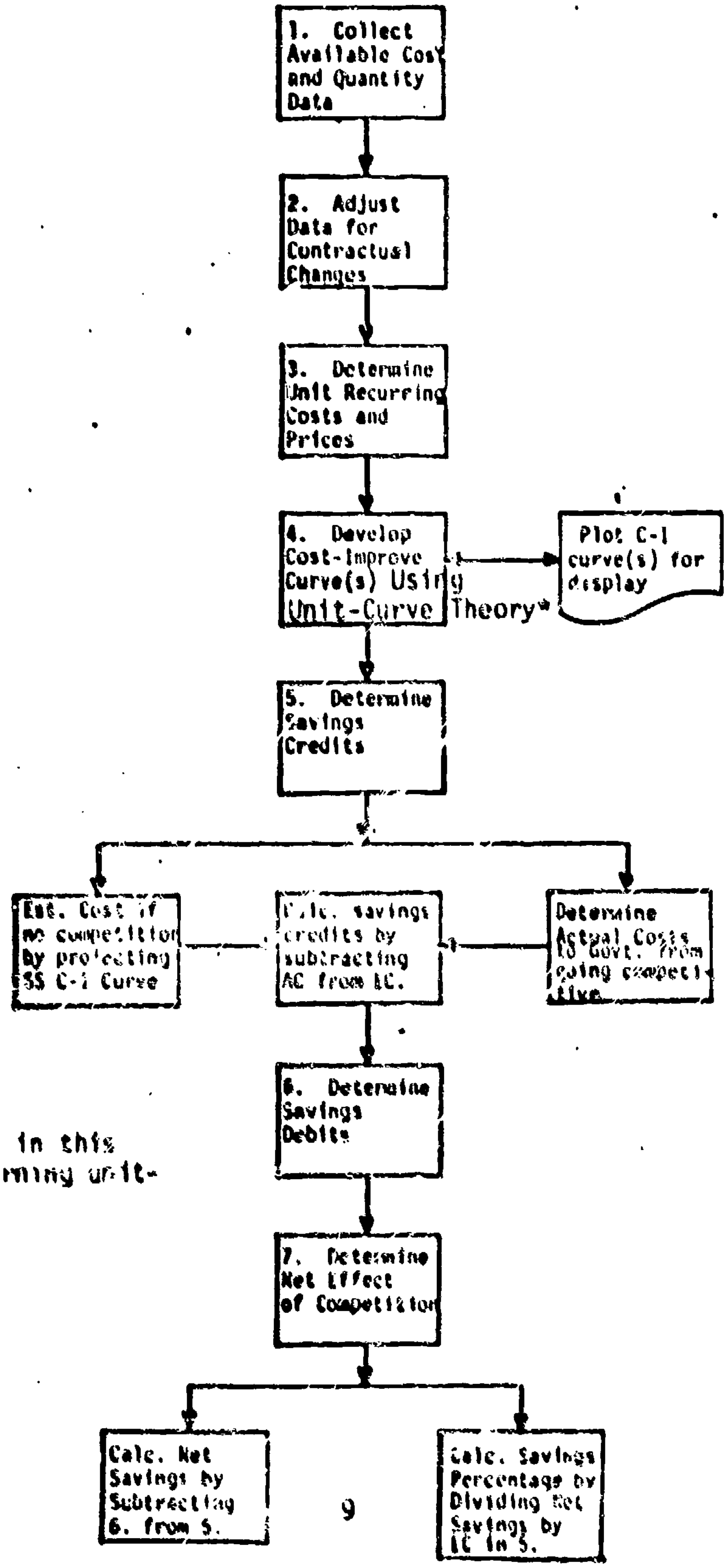
From basic contractual instruments and cost reports, collect the following types of data.

a. Contractors.

b. Contract numbers.

c. Fiscal years of awards.

FIGURE 2-1 FLOW CHART OF ESTIMATED SAVINGS METHODOLOGY



* ALL regression in this report use learning unit-curve theory.

d. Initial hardware unit prices, option prices and total contract prices.

e. Quantities procured.

f. Non-hardware and non-recurring costs which are included in the unit price; e.g.,

(i) data costs.

(ii) facilities costs.

(iii) Special Acceptance and Inspection Equipment (SAIE) costs.

(iv) start-up costs.

(v) Systems Engineering and Project Management costs.

STEP 2. Adjust Data for Contractual Changes.

From contract modifications and engineering changes, determine changes in input data such as:

a. Fiscal year of any change in quantity.

b. Amount of new quantity (increase/decrease).

c. Any change in unit price or option price.

d. Reason(s) for change in unit price.

e. Hardware modifications which significantly altered the item from that which was competed.

An attempt should be made to keep the hardware substantially the same throughout the analysis by adjusting the unit costs and prices to reflect major changes. This is done to minimize the effect of these hardware changes on the competition savings.

STEP 3. <u>Determine Unit Recurring Costs and Prices</u>.

Determine basic unit recurring costs and prices by:

a. Excluding all non-hardware and non-recurring costs from the unit price;

b. Adding profit to unit recurring costs, which include General and Administrative (G&A) costs, to get unit recurring prices;

c. Adjust unit costs and prices to a common base year to account for inflation. Use actual escalation where available; otherwise, use an approved commodity index.

STEP 4. <u>Develop Cost-Improvement Curves</u>.

Although the primary purpose of this step is to obtain an accurate sole source cost-improvement curve for projection purposes, cost-improvement curves should be constructed for each contractor for comparison. Learning unit curve theory should be used in their construction. Split-buy data points for the sole source contractor should be used with caution because of the potential influence of competition on these values. If after a careful analysis they are used, supporting documentation should be prepared. If other factors such as production rate changes or major production breaks affect the sole source cost-improvement curve, adjustments should be made accordingly. Also, if accurate prototype cost data is available, and if the prototypes were manufactured in substantially the same manner as the production lots, they should be included in the sole source curve construction.

a. Calculate algebraic lot mid-points for available lots (monthly, quarterly, or yearly) for the total quantities procured. Beware of problems with concurrent production.[3]

[3] For an analysis of this situation, see "Concurrent Production and the Cost Data Problem: A Solution," Kluge, Arthur J. and Pilling, Donald L., Oct 1975.

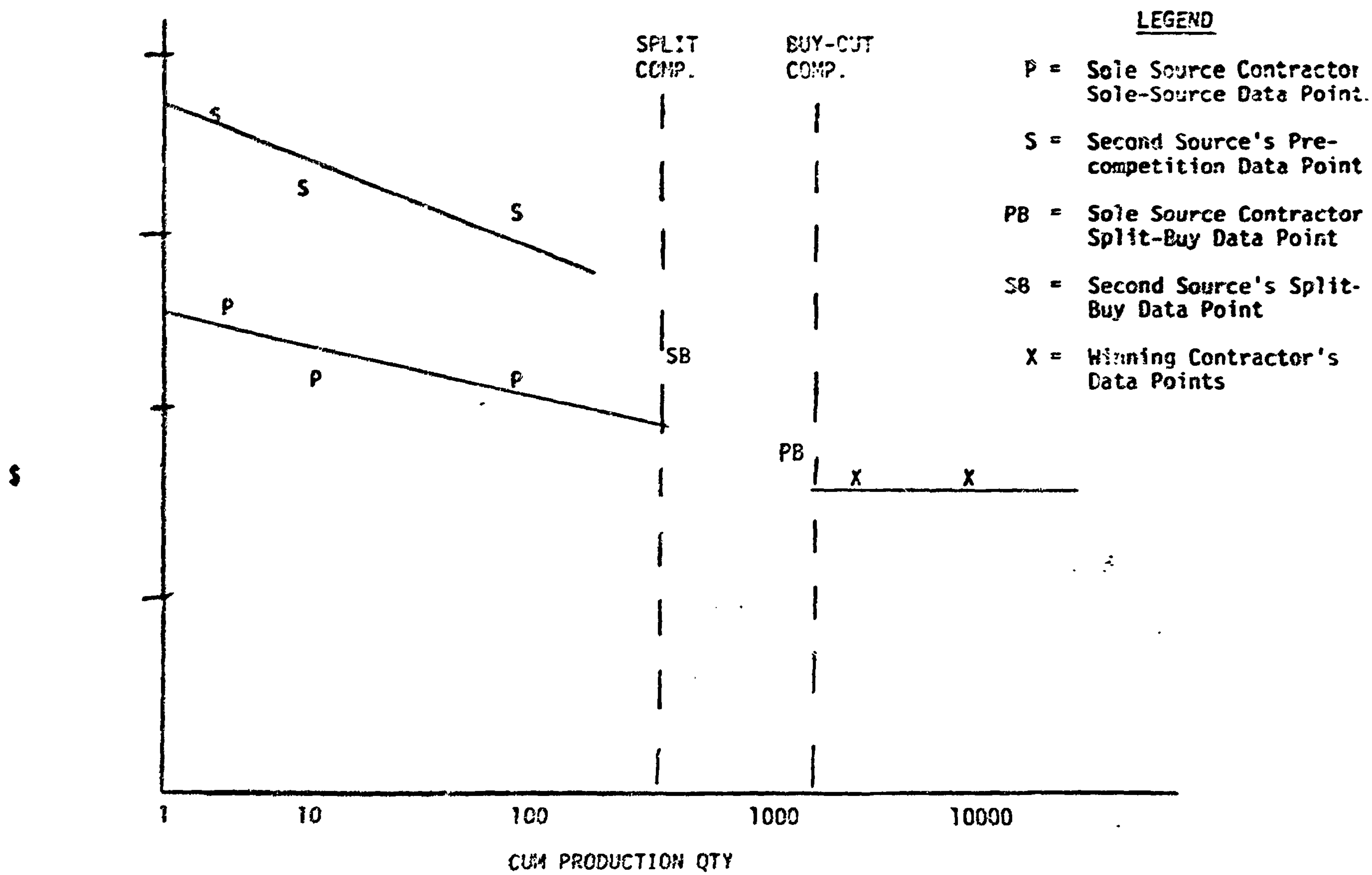


FIGURE 2-2. Example Display of Cost-Improvement Curves

b. For the pre-competition period, determine two cost-improvement curves. One is for the sole source contractor using recurring price data points, and the second is for the second source contractor if there was a second source.

c. For the post-competition period, determine the cost-improvement curve of the winning contractor using those contract price points commencing with the buy-out competition.

d. On one logarithmic grid, plot the cost-improvement curves for each of the three data sets for display purposes. Figure 2-2 illustrates such a display.

STEP 5. Determine Savings Credits.

Determine total savings credits in unit recurring prices by comparing the estimated cost (EC) of not having competition with the actual cost (AC) of the competition. EC is calculated by projecting the sole source cost-improvement curve to cover total program requirements. AC if calculated from the actual costs incurred by the Government from the competition. All split-buy prices and quantities are included in the following calculations.

a. Project the pre-competition sole source cost-improvement curve to cover all procurement quantities except those included in the curve's development and possibly the educational buy of the second source contractor.[4] If the educational units are solely for second source qualification, which they usually are, and would not have been procured if competition

[4] This projection in STEP 5a of the sole source contractor's cost-improvement curve assumes the sole source contractor would continue in a no competition environment on the same learning curve established as a sole source producer.

had not been introduced, the educational buy quantity should be excluded from the projection. Total procurement quantities should include all concurrent requirements planned for in the DOD Budget and Foreign Military Sales (FMS), but exclude follow-on buys solely for FMS. A ten percent fee is assumed in the projection of the sole source courve.

b. From this projection and the actual recurring prices used to develop the sole source cost-improvement curve, calculate EC (the total estimated recurring price for the hardware if no competition had been introduced) by multiplying the production quantities by the unit recurring prices for all procurements and summing these products.[5] Add any post-competition non-recurring costs incurred, commencing with the buy-out competition, so that this no-competition total can be related to the competition total.

c. Calculate the actual total recurring price for the hardware before the buy-out competition (including any split-buy points) by adding the individual recurring price totals of both contractors before buy-out competition. These individual prices are calculated as described in STEP 5b.

d. Project the post competition cost-improvement curve of the winning contractor's actual prices to also cover the future requirements if the program is still active.

e. From this projection, calculate the actual total contract price commencing with the buy-out competition by multiplying the procurement quantities by respective unit prices and summing as in STEP 5b.

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[5] The sole source contractor's non-recurring costs are excluded from consideration in this methodology since they would have been incurred whether or not competition was introduced, and they do not affect the net savings calculation in STEP 7.

f. Calculate AC by adding the totals in STEPS 5c and 5e. Subtract AC from EC in STEP 5b to determine the hardware savings credit due to competition.

STEP 6. Determine Savings Debits.

Determine total savings debits by adding those costs incurred by the Government solely because of competition. Savings debits can result from many different circumstances and should be charged as good judgment dictates. An example of one such debit is the unrecouped progress payments paid to a contractor who goes bankrupt while attempting to produce the item. The more common debits are as follows:

a. Determine the non-hardware and non-recurring prices for the second source by subtracting the total hardware recurring price from the total contract price which includes all costs and quantities (including split-buy contracts).

b. Determine any contractual support prices paid to the [illegible] source contractor for support of the second source contractor.

c. Determine any additional costs due to program stretch-out to develop a second source.

STEP 7. Determine Net Effect of Competition.

a. Subtract the total savings debits in STEP 6 from the total savings credits in STEP 5 to determine the net savings.

b. Compute the net savings percentage by dividing the difference in STEP 7a by the estimated cost total in STEP 5b.

In addition to completing the above methodology, a review of the post-competition cost improvement curve should be made to determine the "buying-in" tendency of the winning contractor. A post-competition slope greater than 1.00 indicates the possibility of a buy-in. If a significant trend is evident, or a large difference in beginning and final unit price exists, the reasons should be determined.

CHAPTER III

ANALYSIS OF WEAPONS SYSTEMS

A. INTRODUCTION.

This chapter presents an analysis of the items which were investigated investigated by APRO. The first part of the analysis is a narrative description of the system followed by the production history. The estimated savings methodology (ESM) application is then presented which provides both the dollar and percentage estimates of savings achieved.

B. ANALYSIS OF SYSTEMS.

1. TOW.

a. System Description.

Tow is a heavy assault weapon designed primarily to destroy enemy tanks, pill boxes, and armored vehicles. The missile is tube launched, optically tracked and wire guided. The system is manned by a crew of four and is man-portable when disassembled. TOW can be fired from a tripod, from vehicles, and in the airborne model can be fired from helicopters.

The system is composed of the missile, launcher, and ancilliary equipment. The three major components of the launcher are the optical sight, the traversing unit, and the missile guidance set. Ancillary equipment includes a battery charger, vehicle mounting kits, and training equipment.

b. Production History.

The first production contract, DAAH01-68-C-2141, for the TOW missile system was awarded to Hughes Aircraft (HAC), the system developer, by letter contract in June 1968. This was a Fixed-Price-Incentive (FPI) contract with incentives on cost, delivery (negative only), and performance. Under this contract, TOW missiles, TOW launchers, and ancilliary items were procured.

The second source contractor for the TOW missile was chosen by standard source selection procedures: Chrysler Corporation was selected over Philco-Ford and Varo. Chrysler was awarded contract DAAH01-69-C-0928 in January 1969. It was a Firm-Fixed-Price (FFP) contract for an educational buy of missiles with options for additional quantities.

In December 1969 and in January 1971, HAC was awarded FFP contracts for the three major components of the launcher. Contract DAAH01-70-C-0318 called for various quantities of Missile Guidance Sets, Optical Sights, and Traversing Units. Contract DAAH01-71-C-0339 was for delivery of the same quantities of each of the three components. In April 1971, FFP TOW missile production contracts were awarded to HAC (DAAH01-71-C-0994) and Chrysler (DAAH01-71-C-0995). These contracts were the result of split competition between HAC and Chrysler. As the winning contractor, HAC received the larger quantity.

The HAC and Chrysler competition for the "buy-out" quantity resulted in HAC being awarded a Fixed Price Economic Price Adjustment (FPEPA) contract (DAAH01-72-C-0418) in November 1971. A second competition between HAC and Chrysler resulted in the award of an FPEPA contract (DAAH01-75-C-0626) to HAC in February 1975.

In 1972 the three major components of the TOW launcher were openly competed; no educational quantity was included. As a result, Emerson Electric Company was awarded a FPEPA contract (DAAH01-72-C-0611) in March 1972. The launcher components were again competed, this time with competition limited to HAC and Emerson. Emerson was awarded contract DAAH01-75-C-0628 in February 1975. Both contracts were multi-year contracts.

c. ESM Application.

(1) Input Data Caveat. As discussed in the estimated savings methodology, two sources of input data were used for the TOW savings calculations. One source was the production contracts for the prime and second source. These TOW missile contracts are DAAH01-68-C-2141, DAAH01-71-C-0994, DAAH01-72-C-0418, and DAAH01-75-C-0626 with Hughes Aircraft Corporation and DAAH01-69-C-0928 and DAAH01-71-C-0995 for Chrysler Corporation. The TOW launcher contracts for Hughes Aircraft Corporation are DAAH01-68-C-2141, DAAH01-70-C-0318 and DAAH01-71-C-0339, and DAAH01-72-C-0611 and DAAH01-75-C-0628 for Emerson Electric Company.

Generally, contract prices alone should not be used to develop learning curves since they usually include non-recurring or start-up costs which increase first unit cost which normally produces a steeper learning curve and overstates unit recurring prices. If non-recurring costs can be isolated from contract prices, or if non-recurring costs are negligible, then contract price data would be acceptable, but it is difficult and sometimes impossible to identify these costs. The only clue available to isolate unit recurring prices from the TOW data is the inclusion in some solicitations and contracts of a clause regarding option prices substantially as follows.

> The Contractor agrees not to include in the price for option quantities any costs of a startup or nonrecurring nature, which costs have been fully provided for in the unit prices of the firm FY 75 quantities, and further agrees that the prices offered for option quantities will reflect only those recurring costs, and a reasonable profit thereon, which are necessary to furnish the additional option quantities. [6]

Contract data does give reliable production quantity figures, although it usually requires considerable effort to track them through the many contract modifications that are prevalent in a major weapons system.

The second source of input data for the TOW savings calculations is the quarterly cost reports prepared and submitted by the contractors. The first few reports on the TOW missile and launcher were submitted on DD Forms 1177, Cost Incurred on Contract, and the remaining reports were submitted on DD Forms 1737, Procurement Information Functional Cost-Hour Report, and 1738, Procurement Information Progress Curve Report, which replaced the DD Form 1177. This form change complicated cost identification since the cost and quantity data usually did not track from the predecessor set to the successor set. In some instances the cost reporting requirement was cancelled altogether which resulted in gaps in the data base.

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[6] MICOM Solicitation Number DAAH01-75-R-0205.

The one serious problem evident from a thorough review of the available TOW cost reports is that they do not provide as good an indicator of contractor learning as intended. There are many reasons for this. First, there appears to be a definition problem in distinguishing between non-recurring cost and recurring cost. Different contractors choose to report them differently. Second, the timing of the costs incurred and reported by the contractor do not correlate to the production quantities delivered and reported. Therefore, there is little or no correlation between the DD Form 1737 and DD Form 1738 submitted together each quarter, and both forms as structured are needed to develop valid cost-improvement curves. Third, the quantities reported in the cost reports do not always agree with the quantities procured in the production contracts. Fourth, the assumptions required to adjust the available cost data so it is useable can result in fitting the data to a preconceived mold. Fifth, there is always the problem of accuracy and reliability of the contractors in preparing the reports.

Notwithstanding these shortcomings in the cost report data which detract from the confidence in the resulting calculations for the TOW system, it is submitted that the estimates presented here represent the most reliable estimates available for the current data base.

(ii) TOW Missile Results. A substantial portion of TOW missile cost is in material and subcontract cost which does not experience the same rate of learning as the manufacturing and assembly effort of the sole source prime contractor. As reported on the TOW missile cost reports, the material and subcontract cost portion of the total unit cost is 35% during the first production lot and 87% during the last production lot before the split competition. After adjusting the reported data for some learning, the material and subcontract portion is roughly 70% of the unit cost during the last lot before competition. The TOW Should Cost Study shows the proposed material and subcontract cost to be 59% of the total for the split competition.[7] These percentages show two things: (1) the material and subcontract portion of the TOW missile cost is substantial, and (2) the various data sources do not substantiate one another as to what the exact percentage is:

Because the material and subcontract portion is substantial, two separate cost projections were made in STEPS 4 and 5 to estimate savings more realistically. One projection was for the sole source prime contractor's manufacturing effort, the second was for the material and subcontract cost. The missile price indices given in Appendix A were used to adjust the cost data for inflation for all missile system studied. Also, the first unit for the TOW missile cost-improvement curve development was assumed to be the first production unit. Sixty-six prototype TOW missiles were excluded. This assumption was also made for the TOW launcher calculations in which fifteen prototypes were excluded.

The unadjusted material and subcontract costs reported by the sole source prime contractor are roughly constant which would result in a flat learning curve. Since it is known that some learning is actually

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[7] TOW Missile Should Cost Analysis, Hughes Team Report. US Army Missile Command, Redstone Arsenal, Alabama 35809. 18 Jan 1971 - 15 Mar 1971.

experienced by the subcontractor, the raw cost data should be adjusted to more reasonably reflect reality, but the available data sources do not provide much assistance.

Herein lies the major problem in estimating the savings from competition for the TOW missile. The amount of learning experienced is dependent upon many factors including who the subcontracts are, which components are subcontracted, and the labor/material mix. The rate of learning varies on a case-by-case basis. Considerable effort would be required to obtain subcontractor learning curve data on all of the TOW subcontractors, even if such data exists. This forces one to assume a reasonable learning rate, thereby assuming a corresponding savings since a substantial portion of the costs are affected.

Figure 3-1 summarizes the results of applying the estimated savings methodology using various learning rates and illustrates the sensitivity of the savings estimate to the assumed learning rate for the material and subcontract cost. A comparison of the total projected unit price of $3,680 using the 95% rate with the $3,797 actual contract unit price for the split buy favors a 95% assumption, but the projected material and subcontract cost of $2,688 does not agree with the $2,113 figure from the TOW Missile Should Cost Study. Judging from historical learning rates and the resultant savings values themselves, the 95% learning rate appears conservative, and the 85% rate appears liberal. Additionally, it is doubtful that the sole source prime contractor could sustain a steep 76% learning

COST CURVE PROJECTION (ACTUAL SOLE SOURCE PRIME RATE %) / (ASSUMED SUB RATE %)			% SAVINGS (LOSS)	$ SAVINGS (LOSS)
76	/	95	22.0	187.2 M
76	/	90	8.5	61.3 M
76	/	85	(7.4)	(45.5 M)
(No Separation)				
86%			10.8	80.2 M

FIGURE 3-1. Sensitivity of TOW Savings Estimate to Assumed Rate for Material and Subcontractor Learning.

rate throughout the TOW production effort. The true percent of savings lies somewhere in the range defined by the two extremes in Figure 3-1. With no additional information available, the best estimate is the mid-point, or 90%, which results in an 8.5% savings estimate.

For comparison purposes, Figure 3-1 also shows the resulting savings estimate if no separation or distinction is made between prime and subcontract costs. This is the procedure commonly followed in major weapon system cost studies.

(iii) TOW Missile Calculations. Using an assumed 90% cost-improvement curve for material and subcontract cost, a savings estimate of 8.5% and $61.3 M results for the TOW missile. Portions of the TOW missile calculations are classified so it is not presented here.

(iv) TOW Launcher Results. The cost reports available for the TOW launcher allowed, with some adjustments, the development of cost-improvement curves for the three major launcher components; i.e., optical sight, missile guidance set, and traversing unit.

Exercising the estimated savings methodology with this data results in a savings estimate of 30.2% or $83.6M for the TOW launcher. Portions of the TOW launcher calculations are classified so it is not presented here. A major portion of the savings can be attributed to the Government not incurring an expense to educate a second source. The launcher complexity, TDP quality, and potential requirements were such that an experienced, capable contractor could bid competitively if willing to accept a reasonable risk.

2. DRAGON.

a. System Description.

The DRAGON is a command-to-line-of-sight guided missile system. Fired by one man from a recoilless launcher, the missile is tracked optically and is guided automatically to the target by electrical impulses transmitted via a wire command link. It is used primarily in an anti-tank role. The weapon consists of two major components - a round and a tracker.

The round consists of the launcher and the missile. The launcher serves the dual purpose of being the handling and carrying container for the missile, as well as providing the initial propulsion force for missile launch. The DRAGON tracker consists of the optical sight, the firing mechanism, an IR sensor and a control signals comparator. Ancillary equipment for the DRAGON system includes training equipment and a test set.

b. Production History.

On 2 October 1967 a letter contract was awarded to the DRAGON system developer, McDonnell Douglas Astronautics Corporation (MCDAC), to conduct a Production Engineering Program, with subsequent production and delivery of system hardware, ancillary items, and engineering services to support the DRAGON Weapon System. The contract was definitized on 28 June 1968 in the amount of $18.2 million for Advance Production Engineering. This portion of the contract was awarded on a Cost-Plus-Award-Fee basis. Subsequent production engineering and hardware provided under this contract were established on a Fixed-Price-Incentive-Fee basis.

Four years of production buys were awarded. Systems hardware procured under this contract were:

Guided Missile and Launcher, Surface Attack, Heat M222

Guided Missile and Launcher, Surface Attack, Inert, M223

Tracker, Infrared, Guided Missile, SU-36

A second source was authorized on both the round and the tracker, to develop a competitive position on each through the use of educational production contracts. The contract for a second source on the DRAGON round was awarded to Raytheon Company on 20 September 1972 on a Firm-Fixed-Price basis for a small educational quantity with options for additional quantities.

The contract for a second source on the DRAGON Tracker was awarded to Kollsman Instrument Company on 23 March 1973, on a Firm-Fixed-Price basis, again for a small educational quantity with full production options.

Both the DRAGON Round and Tracker were authorized for a partial competition phase. Dual award could be made on either a 60/40 or 50/50 percent split of the total FY 75 and/or FY 76 requirements. Awards were to be made on the basis of the lowest evaluated price to the Government. MCDAC won both aspects of the partial competition over Raytheon and Kollsman. The follow-on options were exercised on both winning and losing contracts. This resulted in MCDAC having two 60% production awards for rounds and two 60% awards for trackers. The losers in this phase (Raytheon on rounds and Kollsman on trackers) each received two 40% production awards - one each for the original contract and the option - on their respective items. Both MCDAC contracts were awarded on a Firm-Fixed Price basis. Kollsman's contract was also Firm-Fixed-Price, and Raytheon's contract was awarded Fixed-Price Incentive.

The final buy-out contracts on a winner take all basis were awarded Fixed-Price with Economic Price Adjustment with Raytheon winning for the round and Kollsman winning tracker competition, both over MCDAC. Both contracts were for the FY 7T, FY 77, and FY 78 Program Years and allowance for options in each of those years, plus add-on options for FY 79 and FY 80.

c. ESM Application.

(1) Input Data Caveat. The production contracts with McDonnel Douglas Astronautics Company (MCDAC) for both the DRAGON round and tracker are DAAH01-68-C-0282, DAAH01-76-C-0022, and DAAH01-76-C-0024. Raytheon's contracts for the round are DAAH01-73-C-0189, DAAH01-76-C-0025 and DAAH01-76-C-1271. Kollsman Instrument Company's contracts for the tracker are DAAH01-73-C-0718, DAAH01-76-C-0023, and DAAH01-76-C-1272.

In addition to the DRAGON contract data, quarterly cost reports were reviewed in an attempt to establish realistic cost-improvement curves. The first few reports were submitted on DD Form 1177, followed by DD Form 1737 and 1738. The remaining reports were submitted on DD Form 1921-1, Functional Cost Hour Report, and 1921-2, Progress Curve Report, which were used to replace DD Forms 1737 and 1738 respectively.

Unfortunately, the DRAGON cost reports, like the TOW cost reports, do not provide a good indicator of contractor learning. The reporting requirement was dropped for some production lots, and those reports that were requested and submitted have little use regarding learning. The following warning was given in a cover letter accompanying early reports.

> "Caution should be exercised in the utilization of data reported on the inclosed DD Form 1177's, since the basis for entries does not necessarily conform with the instructions on the reverse side of the form, but rather to implementation agreements between the contractor and MICOM." [8]

The DRAGON cost reports have the same shortcomings discussed in the TOW section, only to a greater degree. There is little correlation between the DD Form 1737 and 1738 or DD Form 1921-1 and corresponding 1921-3 even though submitted together at times. Cost report quantities and contract quantities do not always agree. Too many major assumptions would be required to use what data is available. Therefore, the DRAGON cost reports were not used to develop cost-improvement curves.

The source of cost data that was used is the "DRAGON Baseline Cost Estimate."[9] This study verified the DRAGON round learning rate of 85% that was developed in an earlier study and offered an updated estimate of an 83% rate for the tracker.[10] The earlier curves were developed by government personnel visiting the sole source contractor's plant, reviewing cost and

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[8] Letter to AMCPP-X from AMSMI-IOAO, Subject: Subject Reports DAAH01-67-C 104 and DAAH01-68-C-0282, dated 1968.

[9] "DRAGON Baseline Cost Estimate." US Army Missile Command, Redstone Arsenal, Alabama 35809. Appendix C, 9 May 1975.

[10] "Reassessment of DRAGON Engineering Cost Estimates." US Army Missile Command, Redstone Arsenal, Alabama 35809. Updated December 1972.

accounting records, and interviewing contractor personnel. It appears to be the best learning curve estimate and data source available for DRAGON.

(ii) DRAGON Round Results. Like the TOW missile, a substantial portion of the DRAGON round unit cost is in material and subcontract costs. These costs were 37% of the total recurring unit cost during the first production lot and increased to 67% of lot six cost.[11] Cumulative quantity at that point was only 322 units. The DRAGON Baseline Cost Estimate (BCE) did not separate these costs for projection purposes.

The estimated savings methodology was exercised for the DRAGON round using data from all three of the previously discussed sources.

The calculations using this data resulted in an estimated savings of 2.7% or $8.0M for the DRAGON round. Since the cost projections based on the BCE data are substantiated by actual contract price data for the precompetition period, this estimate appears reasonable and credible. Portions of the DRAGON round calculations are classified so it is not presented here.

(iii) DRAGON Tracker Results. Three data sources were used in an attempt to develop savings estimates for the DRAGON tracker; cost reports, contract data, and the BCE data.

The BCE study chose to stay with the original 87.7% learning rate rather than the updated 83% rate because it was closer to historical rates for electronics hardware. The 87.7% rate produced a 29% or $43M savings estimate for the DRAGON tracker. The 83% rate produced a -8.5% or $6M loss estimate. Neither rate could be substantiated by actual contract

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[11] Ibid.

prices; although the 83% rate provided projections closer to the contract prices. The best estimate of an 85% rate at roughly the mid-point produces a 12% or $12.2M savings estimate. Portions of the DRAGON tracker calculations are classified so it is not presented here.

3. Shillelagh.

a. System Description.

The SHILLELAGH Missile System is a direct fire, boost glide, line-of-sight missile system. Missile tracking and command guidance is accomplished using infrared links between the missile and vehicle mounted guidance and control (G&C) system. The breech-loaded, tank-mounted 152mm gun tube is used for launching the missile. The missile is loaded, aimed and fired in the same manner as conventional ammunition except that sighting with the SHILLELAGH guidance system does not require an estimate of target lead or gun elevation based on range, target velocity, or windage.

The SHILLELAGH Missile System as the primary armament of a tank/vehicle is under the direct command of the Tank Commander. It is employed against all types of armored vehicles likely to be encountered on the battlefield. It also has explosive effect against personnel and unarmored material, including field fortifications.

First deployment of the SHILLELAGH was with the Sheridan vehicle in June 1967.

b. Production History.

The first SHILLELAGH production contract was awarded to the

[12] "Shillelagh Fact Book," Army Missile Command, Redstone Arsenal Alabama 35809. 1974.

system developer, Philco-Ford Aeronutronics Co., Newport Beach, California, in November 1964. This contract, DA-04-495-AMC-555(Z), was a Cost-Plus-Incentive Fee (CPIF) contract under which 1,393 missiles were delivered. The second sole source CPIF production contract, DA-01-021-AMC-13705(Z), required Philco-Ford to deliver 16,552 missiles. It was awarded in December 1965. Philco-Ford's third sole source production contract, DAAH01-67-C-0002, was awarded in FY 67 on a Fixed Price Incentive (FPI) basis. Under this contract 21,846 missiles were procured.

During approximately the same time frame as contract DAAH01-67-C-0002, Martin-Marietta of Orlando, Florida, was developed as a second source of SHILLELAGH missiles. Firm-Fixed Price (FFP) contract, DA-01-021-AMC-14299(Z), required delivery of 4,960 missiles between FY 66 and April 1969. Martin's second FFP production contract, DAAH01-68-C-1020, required delivery of 7,540 missiles between FY 68 and September 1969.

In July 1968, Philco-Ford was awarded the competitive FFP buy-out contract. Under this contract (DAAH01-69-C-0059), Philco-Ford delivered 35,903 missiles.

c. ESM Application.

Contract price and quantity data for the SHILLELAGH Missile were obtained from the Shillelagh Fact Book.[12] The Fact Book also provided extensive cost-improvement curve data. Since the curves in the Fact Book were prepared from early DD Form 1177 reports and visits to the contractor's plant, it appeared adequate to establish a sole source rate of learning

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[12] "Shillelagh Fact Book," Army Missile Command, Redstone Arsenal Alabama 35809. 1974.

for Shillelagh. Figure 3-2. shows the pertinent data and sole source cost-improvement curve for Philco-Ford; Figure 3-3. gives the Martin-Marietta data.

Using this data to apply the ESM results in a savings estimate of 5.9% and $18.3M for Shillelagh. The calculations are shown in Figure 3-4.

4. FAAR.

a. System Description.

The Forward Area Alerting Radar System (FAAR) was developed to extend the capabilities fo the VULCAN/CHAPPARRAL Air Defense Artillery Battalions by providing target intelligence acquired by radar. The advantage is that the weapons operators can be constantly alerted to the movement of enemy aircraft within the combat zone. This can be accomplished for targets at ranges in excess of those possible optically and in addition can be achieved during periods of inclement weather.

The FAAR system provides a highly mobile L-band search radar with IFF capabilities. The radio frequency data link and the target alert data display set provide the means to integrate the radar with the air defense artillery squadrons. The FAAR system includes radar set AN/MPQ-49, Target Alert Data Display Set (TADDS) AN-GSQ-137 and support equipment. The support equipment includes radar test set AN/MPM-57, radar test AN/MPM-59 and production test equipment.

The AN/MPQ-49 is a completely mobile, self-contained alerting radar comprised of radar set AN/TPQ-32, generator set Model SF-5-MD, cargo vehicle, emplacement hardware, ancillary communications equipment and

SYSTEM PHILCO-FORD SHILLELAGH MISSILE TIMEFRAME PRE & POST-COMPETITION

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	RECURRING UNIT COST (72$)		RECURRING UNIT PRICE (72$)
66,67	1,393	1,393	450	12,484.	14,635.	est.	16,099.
67,68	16,552	17,945	7,796	3,970.	4,611.	est.	5,072.
68-70	S 21,846	39,791	27,989	2,531.	2,781.	est.	3,059.
COMPETITION							
70,71	35,903	75,694		1,814.	1,931.		2,049.

S - split buy

est. - estimated

$$Y = 32266\ X^{-.23309}$$

(72$ w/o fee; cost-improvement curve was not developed from above data but from direct cost data for the first two sole source production buys as given in the Shillelagh Fact Book).

FIGURE 3-2. Shillelagh Cost-Improvement Curve and Data for Philco-Ford

SYSTEM: MARTIN-MARIETTA SHILLELAGH MISSILE TIMEFRAME: PRE-COMPETITION

FY		QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT PRICE (TY$)	CONTRACT UNIT PRICE (72$)
67-69		4,960	4,960	--	2,649.	3,251.	3,754
68-70	S	7,540	12,500	--	2,237.	2,944.	3,235.

S - split buy

FIGURE 3-3. Shillelagh Data for Martin-Marietta

FIGURE 3-4. Shillelagh ESM Calculations

Step 5b	$ 106,377,700	P-F	17,945	units
	+ 202,457,600	Proj.	70,249	units
	308,835,300		88,194	
Step 5c	106,377,700	P-F	17,945	units
	+ 66,826,900	P-F split buy	21,846	units
	173,204,600		39,791	
	+ 43,011,700	M-M	12,500	units
	216,216,300			
Step 5e	+ 73,565,200	P-F	35,903	units
	289,781,500		88,194	units
Step 5f	308,835,300			
	- 289,781,500			
	$ 19,053,800		Savings Credits	
Step 6	746,100*		Savings Debits	
Step 7a	19,053,800			
	- 746,100			
	$ 18,307,700		Net Savings	
Step 7b	5.9%			

*Technical assistance to Martin-Marietta from Philco-Ford interconnecting cables. A modified trailer is used in this configuration to transport the generator set, emplacement hardware and interconnecting cables. The AN/MPQ-49 functions integrally with the VULCAN/CHAPARRAL firing batteries and the AN/GSQ-137 display set in order to engage enemy aircraft in forward areas. The aircraft entering an area subject to AN/MPQ-49 radar surveillance is detected by the search radars and interrogated by the IFF system. The target identify range, and azimuth bearing is displayed for the radar operator to interpret. The radar operator can transmit the target identity and location to the AN/GSQ-137 display set at the weapon site to alert the weapons operator to the target's approximate location. One way voice communication is provided from the radar site to the weapon site for verifying display set indications. The AN/GSQ-137 display set indicator array is arranged in a matrix with seven columns and seven rows giving a gridded pattern of 49 squares. Each square contains a friend indicator and foe indicator. The display set as well as the radar is alined to magnetic north. This orientation allows coordination between radar and weapons areas of surveillance and aids in target tracking.

b. Production History.

The Forward Area Alerting Radar (FAAR) was developed by Sanders Associates, Inc., Nashua, New Hampshire. They were awarded the first production contract, DAAH01-69-C-0749, on 29 November 1968. This FPI contract required delivery of TADDS and radar sets. After open competition, Sperry Rand Corporation, Sperry Gyroscope Division, Great Neck, New York, was awarded contract DAAH01-74-C-0779 on 13 May 1974. This FFP contract requires delivery of radar sets and TADDS. The contract resulted from Request for Proposal (RFP) number DAAH01-74-R-0276 under which offers were received from Sanders, Frequency Engineering, Dynell Electronics and Sperry.

c. ESM Application.

(i) Input Data Caveat. Since only a few DD Forms 1921-1 and no DD Forms 1921-2 were available from the Sanders FAAR production effort, cost report data could not be used to develop the sole source cost-improvement curve. An 88% learning rate appears valid based on contract file data and correspondence from Sanders.

(ii) FAAR Results. The application of the ESM using this information produced a savings estimate for the FAAR radar of 16.6% and $4.8M and 18.2% and $2.0M for the FAAR TADDS. Portions of the FAAR radar and TADDS calculations are classified so it is not presented here.

5. AN/PRC-77.

a. System Descriptions.

Radio Set AN/PRC-77 is the successor version to the AN/PRC-25 Radio Set. It is a short range, manpack, transistorized, frequency modulated, portable radio set in a watertight case, and provides radio communications between company and battalion-size combat and combat support units of the field Army. In a manpack configuration, the radio set is capable of reliably communicating over distances of up to three miles with a three foot antenna, up to ten miles with a ten foot antenna, and when used with an amplifier, AM-4306, the distance is extended up to 20 miles. In a vehicular configuration, the radio set is capable of communicating over distances of ten miles with a ten foot antenna and with amplifier AM-4306, up to 20 miles. Radio Set AN/PRC-77 weighs 35 pounds with an amplifier. With frequency synthesizer, the set is capable of transmitting and receiving voice communications on any one of 920 preselected channels, tunable in 50 KHz increments over the frequency range of 20.00 to 75.95 MHz.

The chief elements of the AN/PRC-77 are the RT-841 ( )/ PRC-77, two antennas, an antenna support, harness, storage bag, and handset. The receiver-transmitter unit consists of a series of transistorized plug-in printed circuit modules contained in individual metal housings.

b. Production History.

The production contract history of the PRC-77 radio set is long and complicated. Radio Corporation of America (RCA), Camden, New Jersey, was the developer of the PRC-77, RCA's sole source production contract, DA-36-039-AMC-10410(E), dated 29 June 1966, was an FPI contract which definitized two letter contracts; DAAB05-67-C-0124 and FR-36-039-H6-32018(e). A total of 7,837 radio sets were delivered under this contract. On 28 April 1968, RCA was awarded a second sole source contract, DAAB05-67-C-0170. This FFP contract yielded 11,798 radios.

Invitation for Bid (IFB) DAAB05-68-B-0218 resulted in Electrospace Corporation, Glen Cove, New York, receiving Fixed Price Economic Price Adjustment (FPEPA) contract DAAB05-68-C-0034. This four year, multi-year contract experienced a two year delay in completion and Electrospace was awarded $8,800,000 in relief under Public Law 85-804. A total of 56,312 radio sets were procured under this contract.

On 29 January 1970, Hamilton Watch Company, Systems Division, Lancaster, PA., was awarded FFP contract DAAB05-70-C-4412. This contract, which resulted from IFB DAAB05-70-B-0430, was novated to LTV Electrosystems, Inc., Memcor Division (later to become E-Systems, Inc., Memcor Division), Huntington, Indiana, on 22 April 1971. Prior to the novation agreement, Hamilton Watch Company failed to deliver any production items. E-Systems delivered 16,191 radios under this contract. However, they were over one year late in making final delivery.

Two awards were made under IFB DAAB05-72-B-0012 in June 1973. This IFB was for a three year, multi-year procurement of the AN/PRC-77 and specified that 50% of the quantity was set aside pursuant to the Labor Surplus Area Program. Sentinel Electronics, Inc., Philadelphia, PA., was awarded the set aside portion. Cincinnati Electronics (CE) Corporation, Cincinnati, Ohio, was awarded the non-set aside portion. Sentinel failed to deliver a single production unit, and on 4 June 1976 they were terminated for the convenience of the Government under PL 94-190, the Small Business Emergency Relief Act. Sentinel is seeking a termination settlement in excess of one million dollars. Sentinel's FPEPA contract, DAAB05-73-C-0011, called for delivery of 16,655 units over three years.

CE's FPEPA contract, DAAB05-73-C-0006, requires delivery of 26,147 radios. On 12 May 1976, CE was granted over two million dollars in relief under PL 85-804. This amount has been included in the cost of the radio. On 14 December 1977, CE submitted a claim for $10,721,728. This claim alleges increased costs for everything from specific design defects to lost profits due to the Mexican Peso devaluation in September 1976. Extensive delays in delivery were experienced under this contract.

On 20 June 1973 Bristol Electronics Corporation, New Bedford, Mass., was awarded FFP contract DAAB05-73-C-0009. This contract, which resulted from a competitive negotiation among Electrospace, E-Systems, and Bristol required delivery of 451 radios all to be delivered in April 1974. Delivery was not completed until October 1974.

Competitive negotiations under DAAB05-74-R-0352 were restricted to Bristol, Cincinnati, E-Systems, Electrospace, and Sentinel. Cincinnati and Sentinel were eventually disqualified and award was made to E-Systems on 14 March 1974. Bristol protested the award of this FFP contract (DAAB07-74-C-0173) to the Comptroller General, who, in turn, recommended that the award to E-Systems be terminated for convenience. He later reversed this decision and allowed the award to stand with the recommendation that no options be exercised under the contract (54 Comp. Gen 527). Due to sole source directed foreign military sales, the Army was forced to add 6,782 units to the basic award of 5,464 units, for a total of 12,246 radios.

E-Systems was also awarded a letter contract (DAAB07-74-C-0102) for co-production of the AN/PRC-77 with the Government of Korea. The contract called for 5,235 kits and was awarded 29 March 1974. (This contract and other co-production quantities have been excluded from this study).

On 2 May 1977 E-Systems was awarded sole source contract DAAB07-77-C-0113. This FFP contract requires delivery of 502 radios.

IFB DAAB07-77-B-0171 resulted in the award of FPEPA contract DAAB07-78-C-0107 to Bristol Electronics on 16 November 1977. A total of

10,957 units are to be procured under this contract. In December 1977 Bristol Electronics was awarded a FFP contract for 500 radios. This contract, DAAB07-78-C-0117, was awarded on a sole source basis.

c. ESM Application.

Contract price and quantity data for RCA's PRC-77 production were obtained from contracts DA 36-039-AMC-10410E and DAAB05-67-C-0170. Non-recurring costs were identified in a DCAA Audit Report[13] and subtracted from the contract unit prices to get a sole source cost-improvement curve based on recurring unit prices. This data and cost-improvement curve are given in Figure 3-5. Price and quantity data for all other PRC-77 contractors were obtained from their respective contracts. Figures 3-6 through 3-9 present this data for Electrospace, E-Systems, Cinncinnati, and Bristol respectively.

Because of the substantial PRC-77 ECP activity after the sole source production, an adjustment to the no-competition calculation was necessary as shown in Figure 3-10. This results in a savings estimate for the PRC-77 of $52.6 M and 34.8%. This savings must be viewed in light of the production contract history. There were several delays in delivery and certainly Government administrative expenses were inordinately high.

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13 "Report on Evaluation of Price Proposal," Defense Contract Audit Agency, Philadelphia Region, Camden, New Jersey. December 1966. Audit Report 616-01-03-7-0241.

SYSTEM PRC-77 TIMEFRAME Pre-Competition

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	RECURRING UNIT COST (72$)	RECURRING UNIT PRICE (72$)
67	5,737	5,737	1,841	1,177	1,416	[illegible].568
67	2,100	7,337	6,754	920	1,107	1,220
[illegible]	[illegible]	[illegible]	10,437	920	1,070	1,179
68	[illegible]	19,635	15,361	920	1,070	1,179

$$Y = 3{,}891\ X^{-.13742}$$ (72$ w/o fee)

FIGURE 3-5. PRC-77 Cost-Improvement Curve and Data for RCA

SYSTEM ELECTROSPACE PRC-77 TIMEFRAME POST-COMPETITION

FY	QTY	CUM QTY 1/	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT PRICE (TY$)	CONTRACT UNIT PRICE (72$)
69	4,925	4,925	---	---	---	724.
70	8,354	13,279	---	---	---	754.
*						
72	19,440	32,719	---	---	---	738.
73	23,599	56,318	---	---	---	724.

* Production Break

1/ Due to the lengthy production breaks cum qty is cumulative for each block of production only.

FIGURE 3-6. PRC-77 Data for Electrospace

SYSTEM E-SYSTEMS PRC-77 TIMEFRAME POST-COMPETITION

FY	QTY	CUM QTY 1/	LOT MID-PT	RECURRING UNIT COST (TY$)		CONTRACT UNIT Price (TY$)	CONTRACT UNIT PRICE (72$)
72	16,191	16,191	--	--		517.	517.
•							
75	5,464	5,464	--	--		545.	457.
76	6,782	12,246	--	--	est.	737.	573.
•							
78	902	902	--	--		1,017.	690.

• Production Break est. - estimated

1/ Due to the lengthy production breaks cum qty is cumulative for each block of production only.

FIGURE 3-7. PRC-77 Data for E-Systems

SYSTEM: CINCINNATI PRC-77 TIMEFRAME POST-COMPETITION

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TYS)	CONTRACT UNIT PRICE (TYS)	CONTRACT UNIT PRICE (72S)
75	8,096	8,096	--	--	555.	475.
76	13,525	21,621	--	--	557.	433.
77	4,526	26,147	--	--	557.	399.

FIGURE 3-8. PRC-77 Data for Cincinnati

SYSTEM BRISTOL PRC-77 TIMEFRAME POST-COMPETITION

FY	QTY	CUM QTY 1/	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT PRICE (TY$)	CONTRACT UNIT PRICE (72$)
74	451	451	--	--	590.	550.
•						
76	10,957	10,957	--	--	549.	372.
78	500	11,457	--	--	1,175.	797.

•Production Break

1/ Due to the lengthy production break cum qty is cumulative for each block of production only.

FIGURE 3-9. PRC-77 Data for Bristol

FIGURE 3-10. PRC-77 ESM Calculations

Step 5b	$ 25,467,500	RCA	19,635	units
	114,056,900	Proj.	123,706	units
	11,381,000	Plus ECP's	(92./unit)	
	150,905,400		143,341	units
Step 5c	25,467,500	RCA	19,635	units
	41,288,600	Electrospace	56,312	units
	15,376,200	E-Systems	29,339	units
	4,722,500	Bristol	11,908	units
	11,507,800	Cincinnati	26,147	units
Step 5e	98,362,600		143,341	units
Step 5f	150,905,400			
	- 98,362,600			
	$ 52,542,800		Savings Credits	
Step 6	*		Savings Debits	
Step 7a	$ 52.5 M		Net Savings	
Step 7b	34.8%			

*Potential savings debits exist in outstanding claims against the Government in the amount of $1.3 M by Sentinel and $10.7 M by Cincinnati. If paid by the Government, the net savings would be reduced to $40.6 M and the savings percentage reduced to 26.9%.

6. AN/ARC-13.

a. System Description.

Radio Set AN/ARC-131 is a lightweight multi-channel airborne radio set that provides the pilot and co-pilot of an aircraft with two-way communications between air-to-air and air-to-ground stations on any one of 920 **discrete** channels spaced 50 KC throughout the tactical frequency-modulation (FM) band of 30 to 75.95 megahertz. Frequency selection for the transmitter and receivers is remotely controlled and the selected frequency displayed on the operator's control box. The radio set also serves as a retransmission facility (two radio sets connected back to back) and a homing facility (when used with a homing antenna group and indicator). The equipment operates from an aircraft power supply having a nominal voltage of 27.5 volts DC. The radio set consists of a Receiver-Transmitter RT-823/ARC-131; Control, C-7088/ARC-131; and Mounting, MT-3564/ARC-131. Among the aircraft for which the ARC-131 is intended are the UH-1, AH-1, CH-54, CH-47, and the U-21-RU-21.

b. Production History.

The AN/ARC-131 radio set was developed by the Magnavox Company, Fort Wayne, Indiana, at their own expense. The first full scale production contract, DAAB07-67-C-0150, was awarded on a sole source basis on 14 October 1966. This was a FFP contract under which 2,162 radios were delivered.

On 27 November 1967, delivery orders BG01 and BG02 under basic ordering agreement 34601-68-A-1489 were placed sole source with Magnavox. These FFP orders required delivery of 4,173 AN/ARC-131 radio sets. Sole source contract DAAB07-70-C-0179 was awarded Magnavox on 25 March 1970. Under this FFP contract, 897 radio sets were delivered.

As a result of IFB DAAB07-70-B-0366, Defense Electronics, a Division of DEI Industries, Rockville, Maryland, was awarded a FFP contract for production of 614 AN/ARC-131 radio sets on 26 June 1970. Defense Electronics experienced financial difficulties and failed to deliver the first article. As a result, their contract, DAAB07-70-C-0277, was terminated for default effective June 1971.

Urgent requirements as a result of Defense Electronics' default dictated a return to sole source procurement with Magnavox. Accordingly, Magnavox was awarded FFP contract DAAB07-72-C-0148 on 30 March 1972. Options and sole source add-ons to this contract result in a total of 1,101 radio sets being procured.

c. ESM Application.

(1) Input Data Caveat. Magnavox contract prices and quantities from the three sole source production contracts were used to develop the sole source cost-improvement curve for the AN/ARC-131 because they contained negligible non-recurring costs. Two earlier contracts, DA-28-043-AMC-01846 and DA-28-043-AMC-02330, provided for the production and test of eleven prototypes and most of the minimal non-recurring expenses required for

follow-on production. Figure 3-11 gives this data and cost-improvement curve, along with their post-competition prices and quantities.

(ii) ARC-131 Results. The ESM application on the AN/ARC-131 shows a net loss of $.6M and 2.1%. The loss may be partially explained by the relatively small quantity available for a competitive buy. Figure 3-12 presents the ESM calculations.

7. AN/UPM-98.

a. System Description.

Radar Test Set AN/UPM-98 is a transportable test set consisting of two separate drawer assemblies mounted in a common equipment case. The upper drawer assembly, Radar Test Set TS-1253A/UP, consists of a main frame chassis into which are plugged the following four functional units: the Display unit, Sweep and Intensity Mark unit, Crystal Mark and Sync unit, and SIF Coder unit. The lower drawer assembly, Coder Simulator SM-197A/UPM-98, consists of a main frame chassis with two functional plug-in units: the Cal-Control unit and the Integgorgation Coder unit. All operating controls, switches, connectors, indicators, and fuses are located on the front panels of the applicable units. A compact accessory box fixed to the top of the common equipment case accommodates the accessory items.

b. Production History.

Admiral Corporation, Government Electronics Division, Chicago, Illinois, developed the radar test set AN/UPM-98. They had previously produced 371 units under Navy contract N08SR-9-5066 when they were awarded sole source letter contract DAAB05-68-C-0964 in June 1968. The FFP contract was definitized in December 1968 for 65 units. In January 1969, an option

SYSTEM MAGNAVOX AN/ARC-131 TIMEFRAME PRE and POST-COMPETITION

FY	QTY	CUM QTY	LOT MID-PT		RECURRING UNIT COST (TY$)		RECURRING UNIT COST (72$)	RECURRING UNIT PRICE (72$)
67,68	2,162	2,162	786		2,563.		3,031.	3,425.
69,70	4,173	6,335	4,063		2,765.		3,063.	3,381.
71	897	7,232	6,779	est.	2,705.	est.	2,837.	3,121.

$Y = 3532.\ X^{-.02164}$ (72$ w/o fee)

est. - estimated

POST-COMPETITION

FY	QTY	CUM QTY	CONTRACT UNIT PRICE (TY$)		CONTRACT UNIT PRICE (72$)
73	657	657	3,452.	--	3,335.
75	280	937	4,960.	--	4,160.
76	164	1,10[illegible]	5,752.	--	4,474.

FIGURE 3-11. AN/ARC-131 Cost-Improvement Curve and Data for Magnavox

FIGURE 3-12. AN/ARC-131 ESM Calculations

Step 5b	$ 24,313,300	MAG	7,232	units
	+ 3,523,200	Projection	1,101	units
	27,836,500		8,333	units
Step 5c	24,313,300	MAG	7,232	units
Step 5e	+ 4,089,600	MAG	1,101	units
	28,402,900		8,333	units
Step 5f	27,836,500			
	- 28,402,900			
	$ (566,400)		Savings Credits	
Step 6	30,800*		Savings Debits	
Step 7a	- 566,400			
	- 30,800			
	$ (597,200)		Net Savings	
Step 7b	(2.1%)			

*Unrecouped progress payments to a contractor terminated for default.

was exercised for an additional 65 units.

As a result of IFB DAAB05-70-B-0545, Monmouth Industries, Inc., Neptune, New Jersey, was awarded FFP contract DAAB05-70-C-31819 in June 1970. The basic contract called for 65 test sets. Options were exercised on 12 June 1970 for an additional 14 units. On 8 January 1973, the Monmouth Industries contract was terminated for default. The default was due to financial difficulties which prompted Continental Bank of Philadelphia to foreclose on various loans to Monmouth. No deliveries were made under this contract.

On 28 January 1971, Dero Research and Development Corporation, Huntington, New York, was awarded FFP contract DAAB05-71-C-3117 for 65 AN/UPM-98 radar test sets. The contract resulted from an IFB and was valued at $276,750.00. It was ultimately terminated for convenience. No deliveries were made under this contract.

Due to the delays caused by Monmouth and Dero, limited competition between Admiral (now ASC Systems Corporation) and Target Corporation of North Brook, Illinois, was authorized. Admiral was then producing the AN/UPM-98 for Germany, England, Australia and Canada. Target was then in production for France, Iran, Germany, and England. Admiral won the competition and was awarded FFP contract DAAB05-73-C-1635 on 28 June 1973. This contract required delivery of 124 units.

c. ESM Application. The available price and quantity data is meager for the UPM-98. This required the assumption of a sole source rate of learning based upon historical averages for electronics and discussions with the contractor. Figure 3-13 shows the available data and assumed cost-improvement

SYSTEM: ADMIRAL AN/UPM-98

TIMEFRAME PRE AND POST-COMPETITION

FY	QTY	CUM QTY	MID-PT (NAVY)	RECURRING UNIT COST (TY$)	RECURRING UNIT PRICE (TY$)	RECURRING UNIT PRICE (72$)
PRE '69	371	371	--	--	--	--
69	130	501	435		9,552.	10,413.
74,75	124	625	562	--	9,823.	8,676.

$Y = 43150 \; X^{-.234}$ (assumed per contractor; 72$ with fee)

FIGURE 3-13. AN/UPM-98 Cost-Improvement Curve and Data for Admiral curve. Figure 3-14 gives the ESM calculations that result in $77,200 and 3.0% savings estimates.

8. PP-4763/GRC.

a. System Description. Power supply PP-4763/GRC is a solid state power supply developed by Christie Electric Corporation, Los Angeles, Calif. It is capable of supplying 50 amp DC output at nominal 28VDC, from 115 VAC or 230 VAC, 50 to 60 Hz inputs. It is used to operate the AN/GRC-106, AN/GRC-122, and AN/GRC-142 radio sets.

b. Production History.

Christie was awarded the first production contract, DAAB07-68-C-0434 on a sole source basis in June of 1968. Under this contract, 1,818 items were produced.

IFB DAAB05-70-B-0578 resulted in an award for production of 635 units to Defense Electronics, Division of DEI Industries, Inc., Rockville, Maryland, on 8 June 1970. Due to inadequate cash flow and foreclosure by Mercantile Financial Corporation of Chicago, no deliveries were made under this contract. Accordingly, FFP contract DAAB05-70-C-3839 was terminated for default on 1 October 1973.

Industrial Electronic Research Enterprises, (IERE), Palo Alto, California, was awarded contract DAAB05-71-C-3126 on 31 March 1971. This FFP contract, which resulted from IFB DAAB05-71-B-0183, required delivery of 951 PP-4763 power supplies. IERE was eventually merged with the Information and Computing Centers Corporation, also of Palo Alto, California.

FIGURE 3-24. UPM-98 ESM Calculations

Step 5b	$ 1,353,700	Admiral	130 units
	+1,216,100	Proj.	124 units
	2,569,800		254 units
Step 5c	1,353,700	Admiral	130 units
Step 5e	+1,075,800	Admiral	124 units
	2,429,500		254 units
Step 5f	2,569,800		
	-2,429,500		
	$ 140,300		Savings Credits
Step 6	63,100*		Savings Debits
Step 7a	140,300		
	- 63,100		
	$ 77,200		Net Savings
Step 7b	3.0%		

*Unrecouped progress payments to a bankrupt contractor

Due to financial difficulties, the contractor made no deliveries and the contract was terminated for default on 14 July 1972.

Urgent requirements for the PP-4763 necessitated a return to sole source procurement from Christie. Contract DAAB05-73-C-1615 was a FFP contract awarded on 23 May 1973. Under this contract, 198 units were procured.

The next two contracts for the PP-4763 were awarded under the 8(a) provisions of the Small Business Act. The 8(a) contracting program allows elements within the Department of Army to contract delivery with the Small Business Administration (SBA). The SBA, in turn, awards a subcontract directly to a minority enterprise which has been certified by the SBA as having the capacity and credit to perform the contract requirements. It is in essence a sole source procurement.

The first of these 8(a) contracts was awarded to Multiplex-West Corporation, (later West Electroncis, Inc.), Poplar, Montana. The Army's FFP contract number is DAAB05-73-C-1607, dated 11 March 1973. The SBA FFP contract number is SB812-8(a)-74-C-0305 dated 13 September 1973. Delivery of 745 units is required under this procurement. The other 8(a) contract was awarded to King Electronics, Inc., Philadelphia, PA. The Army FPEPA contract is DAAB07-76-C-1307 dated 30 March 1976. The SBA FPEPA contract is SB3-1-0-8(a)-76-C-114 dated 30 March 1976. Under this contract, 478 units are to be delivered.

c. <u>ESM Application</u>. The data available on the PP-4763/GRC was not adequate to establish a sole source cost-improvement curve. It was excluded from the regression development for the forecasted savings methodology for this reason. If a conservative 95% learning rate is assumed, roughly a breakeven situation results as shown in Figure 3-15. Figures 3-16 and 3-17 give the available data and assumed curve.

FIGURE 3-15. PP-4763/GRC ESM Calculations

Step 5b	$ 2,241,600	CEI	1,818	units
	+ 2,933,200	Proj.	2,669	units
	5,174,800		4,487	units
Step 5c	2,241,600	CEI	1,818	units
	234,800	CEI	198	units
	740,500	MPX	745	units
	571,200	KING	478	units
	- 1,372,800	Proj.	1,248	units
Step 5e	5,160,900		4,487	units
Step 5f	5,174,800			
	- 5,160,900			
	$ 13,900		Savings Credits	
Step 6	-		Savings Debits	
Step 7a	13,900			
	-			
	$ 13,900		Net Savings	
Step 7b	0.3%			

SYSTEM: CEI PP-4763/GRC

TIMEFRAME: PRE AND POST-COMPETITION

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT PRICE (TY$)	CONTRACT UNIT PRICE (72$)
69	1,818	1,818	--	--	1,095.	1,233.

$$Y = 1990 X^{-.0740}$$ (assumed; 72$ with fee)

POST COMPETITION

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT PRICE (TY$)	CONTRACT UNIT PRICE (72$)
74	198	198	--	--	1,271.	1,186.

FIGURE 3-16. PP-4763/GRC Cost-Improvement Curve and Data for CEI

SYSTEM PP-4763/GRC

TIMEFRAME POST-COMPETITION

FY	QTY	CUM QTY	LOT MID-PT	RECURRING UNIT COST (TY$)	CONTRACT UNIT Price (TY$)	CONTRACT UNIT PRICE (72$)
KING ELECTRONICS						
76	478	478	--	--	1,337.	1,155.
MULTIPLEX WEST						
74	745	745	--	--	1,066.	994.

FIGURE 3-17. PP-4763/GRC Data for King Electronics and Multiplex West

CHAPTER IV

FORECASTED SAVINGS METHODOLOGY

A. INTRODUCTION

Before the Government invests substantial amounts of money to introduce competition in a weapon system acquisition, it needs to know what the potential cost savings are from doing so. The organized data base established during this project has allowed the development of a forecasted savings methodology to assist in estimating these savings.

There are three major parts to the forecasted savings methodology. The first is a competition screen or criteria that must be met in order to consider competition. The second part is a forecasting methodology which provides an estimate of expected savings by considering those quantitative factors which affect savings. It contains a regression model to predict the competitive bid price. The third part is a competition index which summarizes an analysis of the qualitative factors influencing savings. The competition index can be used to temper the numerical estimate from the forecasting model.

B. COMPETITION SCREEN

In today's procurement environment of highly complex military-systems, competition is in many instances difficult, if not impossible to achieve. It is often difficult to find two responsible companies that can successfully produce a given complex item, requiring rigidity to a delivery schedule within the constraints of quality and price.

This section presents a summary of some of the factors which influence the competitive environment and discusses some of the procurement techniques which may be used to overcome a non-competitive situation. These factors effectively serve as a screen for candidate systems being considered for competition. Some factors are absolute in their influence; others are not as stringent. Figure 4-1 is a summary of those factors which, when present, have either a direct or an indirect influence on our ability to introduce competition. The effect of any one factor may be diminished by the degree to which it affects the item and the spectrum of contractors which could conceivably compete in a given situation. A brief discussion of each factor follows the figure.

FIGURE 4-1

Factors Influencing Competition

1. Prohibitively High Initial Start-up Costs.
2. Lack of a Definitive Technical Data Package or a "Soft" Technical Data Package.
3. Proprietary Data-Technology Transfer.
4. Congressional Interests-Budget Constraints.
5. Inadequate Production Quantities.
6. Economic Climate.
7. Length of Planned Production Cycle.
8. Critical or Scarce Materials.
9. Non-Conformance to Cost Accounting Standards
10. Special Tooling/Test Equipment.
11. Testing Requirements
12. Government/Industry Wide Cash Flow Problems

1. High Initial Start-up Costs. Start-up costs for the production of a major weapons system are generally high. They may be so high that competition is not feasible.

2. Technical Data. A reasonably firm technical data package (TDP) is a requirement for a meaningful competition on the production buys of an item. A "soft" or incomplete TDP can be resolved through the expenditure of additional time and money, so that a complete TDP can be provided for competitive purposes.

3. Proprietary Data-Technology Transfer. The inability to transfer proprietary data or trade secrets of an independently developed item serves as a deterrent to competition for the production of that item.

4. Congressional Interests - Budget Constraints. Budget constraints imposed by Congress through appropriations can dictate a single source due to lack of funding for securing competition and the reduction of quantities which can be procured within funding constraints.

5. Inadequate Production Quantities. Competition must be eliminated when the costs of securing competition cannot be justified or ammortized over an economical quantity.

6. Economic Climate. The general economic climate in industry may be such that Government business is neither needed nor desired.

7. Length of Planned Production Cycle. The length of the production cycle can be a deterrent to some contractors. Problems can be encountered with capacity in terms of monthly requirements or completion for final deliveries. A change in delivery schedule, either in production quantities per month or a stretchout of the schedule, can alleviate capacity/facility

problems that some contractors may encounter.

8. Critical or Scarce Materials. The inability of some contractors to obtain critical or scarce materials may remove them from competition. The Government can secure a priority rating for a contractor to obtain these materials.

9. Non-Conformance to Cost Accounting Standards. Contractors may lack a satisfactory accounting system for conformance to a specific Cost Accounting Standard. Waivers may be secured under certain conditions which could permit competition.

10. Special Tooling/Test Equipment. The lack of adequate tooling or test equipment may prevent a competitive situation. There may be only a single piece of required tooling available in the possession of one contractor, and the lack of tooling for other potential sources will create a distinct competitive advantage. The Government can fund production of additional tooling or test equipment.

11. Testing Requirements. Testing requirements including inspection facilities/systems, first article requirements and use of Government inspectors are additional factors which can affect competition. Relaxation of first article requirements or tolerances may relax restraints; however, this may result in later problems. Use of Government inspection assistance could be considered.

12. Government/Industry Wide Cash Flow Problems. Cash flow problems can be a deterrent to competition in that contractors may not be able to provide sufficient capital to commence and sustain a productive effort. The provision of progress payments, unusual progress payments, advance payments, or other

Government financing is a tool which can be used to alleviate cash flow problems.

Two other procurement techniques which can be used to secure competition are leader company procurements and multi-year procurements. Leader company procurement involves the sole source or developer of an item furnishing engineering/manufacturing assistance to a second source. This technique can be implemented by: (1) the prime subcontracting a portion of work to a second source; (2) a prime furnishing assistance to a second source also under a prime contract; or (3) a prime serving as a subcontractor to the second source who has a contract. The use of multi-year procurement can broaden the competitive base by allowing participation by companies not able to compete for lesser quantities. This is particularly true when high start up or facility costs are involved. The non-recurring costs are distributed over a greater quantity which tends to reduce any price advantage accruing to a company already in production.

C. FORECASTING METHODOLOGY

If the candidate system passes the competition screen, a forecast of the expected savings is needed. A forecasting methodology which is structured similar to the estimated savings methodology, was developed to provide this forecast. It contains a regression model based upon data from the systems reviewed during this project to forecast the unit price of the competitive procurements.

1. Regression Model.

Figure 4-2 summarizes the system data used to develop the regression model. It shows the arithmetic average of the percent price reduction in contract unit price to be 13.7%. However, there is a very large dispersion about that average with a high of 52.8 percent and a low of -29.4 percent.

FIGURE 4-2. REGRESSION MODEL DATA

SYSTEM	FIRST UNIT COST (72$)	SOLE SOURCE CURVE EXPONENT	TOTAL PROGRAM QUANTITY	QUANTITY AFTER COMPETITION	RATIO OF QUANTITIES (QAC/TPQ)	PROJECTED SS UNIT PRICE (72$)	ACTUAL UNIT PRICE (72$)	PERCENT PRICE REDUCTION
1	49223.	-.201est.avg.	279211	247098	[illegible]	2412.	2114	12.4
2	62260.	-.105 avg.	9815 avg.	8893	.906	27030.	17702.	34.7
3	[illegible]	-.2340	152455	69962	.459	1833.	1828.	2.9
4	44503.	-.1390	14335	8422	.562	6763.	5935.	12.2
5	32266.	-.2331	88134	35903	.407	2882.	2611.	9.4
6	315565.	-.184 est.	175	85	.436	141748.	85805.	39.5
7	10384.	-.184 est.	2154	1519	.634	3941.	2714.	31.1
8	3391.	-.1374	143401	123706	.863	1014.	589.	41.9
9	3532.	-.0216	8333	1101	.132	3200.	3714.	-16.1
10	43150.	[illegible] est.	[illegible]	[illegible]	.428	9807.	8676.	11.5
11	[illegible]	-.266 est.	[illegible]	[illegible]	1.000 *	13360	6309.	52.8
12	45949.	-.294	67054	48265	.720	2033.	2151.	- 5.5
13	15352.	-.098	9955	9530	.957	6793.	6748.	0.7
14	530226.	-.321	5927	4967	.838	44148.	46517.	- 5.4
15	101619.	-.310	45050	33955	.754	4382.	3202.	26.9
16	286209.	-.260 avg.	12099 avg	6516 avg	.539	27655.	35735.	-29.4

est. - estimated

avg. - weighted average

*Shrike data was developed from a sole source procurement of similar configuration thus resulting in a 1.000 ratio. Details are contained in the Tecolote report.

MEAN = 13.7

Percent price reduction and actual unit price were the dependent variables considered.

The general criteria used in selecting the best independent variables for the regression model were that the variables had a:

a. high correlation with the dependent variable and low correlation with other independent variables;

b. high significance level in that correlation; and

c. narrow width for the confidence interval around the prediction.

No restrictions were made on the form the model took; although a simple, easy-to-use model was desired.

The final regression model was obtained by checking each independent variable and its different expressions; i.e., logarithm, square, square root, etc., with the dependent variables and selecting the combination that best met the criteria above. Products and quotients of the independent variables were also tried with no improvement in the model fit. Equation (1) gives the log-linear form of the regression model chosen.

$$LAUP = (.967118)\ (LPUP) - (.226109)\ (LROQ) \tag{1}$$

where:

LAUP is the logarithm of the actual unit price of the competitive procurements;

LPUP is the logarithm of the projected unit price from the sole source cost-improvement curve over the same quantity as used for LAUP;

LROQ is the logarithm of the ratio of the quantity procured after competition (commencing with the buy-out competition) to the total program quantity

Equation (2) gives the model in its simplified, non-linear form.

$$\text{Actual Unit Price} = \frac{(\text{Projected Unit Price})^{.967118}}{(\text{Ratio of Quantities})^{.226109}} \qquad (2)$$

The independent variable, LPUP, reflects the influence of the slope of the sole source cost-improvement curve since the projected unit price is a function of the first unit cost, sole source cost-improvement curve exponent, and lot mid-point of the quantity procured after the sole source procurements. LPUP also includes any non-recurring costs expected during the buy-out competition. The independent variable, LROQ, reflects the importance of the quantity available for the buy-out competition expressed as a percentage of total program quantity.

The most influential independent variable is LPUP whose correlation with the dependent variable LAUP, is 1.00. The second independent variable, LROQ, is not as highly correlated with LAUP (-.71); but as a "fine tuner" it improves the model logically by further adjusting the rough estimate from LPUP. When both LPUP and LROQ are included in the model, they are significant at the 100% and 90% levels respectively. There is a moderate (.70) correlation between the two independent variables. The multiple correlation coefficient is .9997.

Figure 4-3 shows how well the model fits the data. The percent deviation between the observed value and the predicted value of LAUP ranges from -5.19 to 4.53. Figure 4-4 is a scatter diagram of the data.

The following example illustrates the use of equation (2) to forecast a competitive bid price. If the projected unit price of a candidate missile is $5000 and the competition structure allows 75 percent of the program requirement to be procured during the buy-out competition, the predicted actual unit

FIGURE 4-3

Table of Residuals for Regression Model Data and Analysis of Variance

CASE NO.	OBSERVED VALUE	PREDICTED VALUE	RESIDUAL	% DEVIATION
1	7.6563	7.5597	0.96595E-01	1.28
2	9.7814	9.8936	-0.11218	-1.13
3	7.5110	7.4687	0.42235E-01	0.57
4	8.6886	8.6595	0.29099E-01	0.34
5	7.8675	7.9076	-0.40063E-01	-0.51
6	11.360	11.635	-0.27508	-2.36
7	7.9062	8.1100	-0.20381	-2.51
8	6.3784	6.7274	-0.34895	-5.19
9	8.2199	8.2634	-0.43514E-01	-0.53
10	9.0683	9.0509	0.17459E-01	0.19
11	8.7497	9.1876	-0.43791	-4.77
12	7.6737	7.4434	0.23024	3.09
13	8.8170	8.5434	0.27356	3.20
14	10.748	10.384	0.36399	3.51
15	8.0715	8.1734	-0.10185	-1.25
16	10.485	10.031	0.45428	4.53

STANDARD ERROR OF THE ESTIMATE = 0.25859

ANALYSIS OF VARIANCE FOR THE NO-INTERCEPT MODEL

SOURCE	DF	SS	MS
REGRESSION	2	1233.0	616.49
ERROR	14	0.93616	0.66869E-01
TOTAL	16	1233.9	

9219.431 = F-RATIO, A 100.00% VALUE.

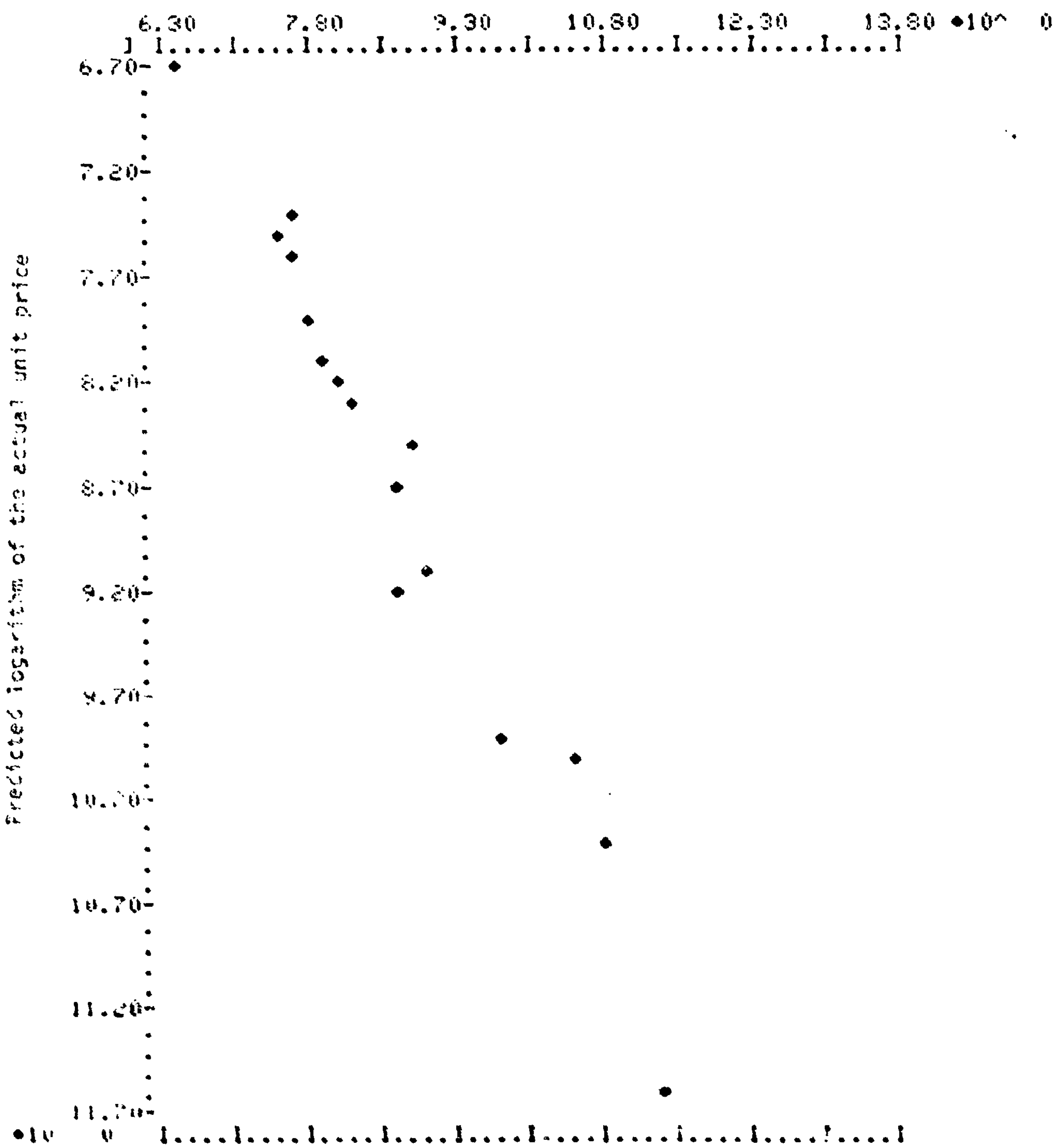
0.9996 = MULTIPLE CORRELATION COEFFICIENT.
0.9992 = INDEX OF DETERMINATION.
0.9991 = "ADJUSTED" INDEX OF DETERMINATION.
(COMPUTED FROM MOMENTS ABOUT THE ORIGIN)

0.25859 = STANDARD ERROR OF ESTIMATE
2.977% OF MEAN OF LAUP

FIGURE 4-4

Scatter Diagram of Regression Model Data

◆ Observed logarithm of the actual unit price



price is $4033. This is determined by solving equation (2) for AUP, given PUP and ROQ, as follows:

$$AUP = \frac{(5000.)^{.967118}}{(.76)^{.226109}}$$

$$AUP = 4033$$

The respective confidence bands around this prediction are shown below:

CONFIDENCE LEVEL	LOWER BOUND	PREDICTED VALUE	UPPER BOUND
95%	3504	4033	4641
90%	3593	4033	4526
85%	3650	4033	4456

One additional use of equation (2) is to determine the ratio of quantities at which the projected unit price equals the forecasted unit price. For this same example, it is 29.0 percent calculated as shown below:

$$5000. = \frac{(5000.)^{.967118}}{(ROQ)^{.226109}}$$

$$ROQ = .290$$

This may be useful to assist in structuring the competition to be sure the quantity remaining for competition is adequate to expect a savings from the competitive bid price.

2. Methodology.

The forecasted savings methodology contains the regression model discussed above to forecast the actual competitive bid price. This prediction is compared with the expected sole source price which is obtained by projecting the sole source cost-improvement curve to cover the quantity needed. The difference between these two prices; i.e., the projected sole source price versus the predicted competitive price, multiplied by the competitive quantity determines the expected savings credits. Expected savings debits are subtracted from this savings credits to get the net expected savings from introducing competition. The methodology details follow.

STEP 1. Obtain the input data necessary to exercise the forecasting methodology.

a. Yearly hardware requirements budgeted for DOD and concurrent foreign military sales.

b. The best available estimate of the sole source contractor's learning curve. The prices or costs should be adjusted to reflect only recurring unit costs plus profit. Non-recurring or start-up costs should be excluded for projection purposes.

STEP 2. Construct the cost-improvement curve for the sole source contractor using unit curve theory.

a. Calculate algebraic lot mid-points for the available quantity information.

b. Adjust unit recurring price data to a common base year using a specific commodity price index or other approved inflation factor.

c. Plot unit recurring price versus lot mid-points on a logarithmic grid and determine first unit cost and slope of the curve.

STEP 3. Determine total savings credits.

a. Project the sole source contractor's cost-improvement curve to cover expected hardware requirements.

b. From this projection, calculate the expected total recurring price if no competition were introduced by multiplying the lot mid-point quantities by the unit recurring prices for all requirements and summing these products. Add any non-recurring costs expected during the buy-out competition to get the expected no-competition total contract price (excluding sole-source non-recurring costs). Discount these prices and remaining calculations to the present year if discounting is included in the analysis.[14]

c. Forecast the actual unit price of the competitive procurement using the following regression model:

$$AUP = \frac{(PUP)^{.967118}}{(RQQ)^{.226109}}$$

where

AUP = the expected actual unit price of the competitive procurement;

PUP = the projected unit price of a sole source procurement calculated by extrapolating the sole source cost-improvement curve (including any non-recurring costs expected during the buy-out competition) and

RQQ = the ratio of the quantity to be procured in the buy-out competition to the total program quantity.

Calculate the expected competitive contract price by multiplying AUP by the quantity to be procured in the buy-out competition.

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[14] AR 11-28. Economic Analysis and Program Evaluation for Resource Management. 2 Dec 75.

d. Calculate the total recurring price for quantities purchased from the prime (sole source) contractor before the competition, including split-buy points if appropriate. If a second source is planned before buy-out competition, their total contract price (including non-recurring costs) should be determined and added to that of the prime contractor to get a pre-competition total price (excluding sole source non-recurring costs).

e. Subtract the sum of Steps 3c and 3d from the total in Step 3b to determine the expected savings credits due to competition.

STEP 4. Determine total savings debits.

a. Determine price to develop the second source, if planned, by multiplying the number of items consumed in the educational buy by the basic unit price for those items consumed.

b. Determ[illegible] other costs incurred solely to support competition. Administrative costs to the Government of awarding and administering the second source procurement should be developed and treated as a savings debit.

c. Determine the contractual support price paid to the prime contractor to support a second source.

d. Determine any additional costs due to program stretch-out to develop a second source.

e. The sum of costs in Steps 4a through 4d is the expected savings debits.

STEP 5. Determine the expected effect of competition.

a. Subtract the total savings debits in Step 4e from the total savings credits in Step 3e to determine the expected net savings.

b. Compute the expected savings percentage by dividing the savings in Step 5a by the total price in Step 3b.

c. Determine the expected cross-over point by calculating the quantity at which the savings debits equals the savings credits.

D. COMPETITION INDEX.

The quantitative results derived from the forecasting methodology must be viewed in light of the qualitative factors which influence potential savings due to competition. These considerations will vary between systems, contractors, and industries. In a given situation some factors may have an extremely strong positive or negative influence, or they may have no influence.

To apply the competition index, one evaluates the various factors as to the impact they are likely to have on the competitive environment. This evaluation ranges from "extremely strong increasing influence" thru "no influence" to "extremely strong decreasing influence." A numerical score ranging from +10 to -10 is thus assigned for each factor. A relative weight indicating the overall importance of the factor being considered to the other factors should be assigned if the factors are not considered to be equal in weight. For comparability among weapon systems, the factor weights should be normalized after their relative importance is established. The summation of the product of the normalized weights and scores is the competition index. This index is then compared with the index for other systems in the data base. Figure 4-5 contains the format for computation of the competition index.

1. Perception of Competitive Position. A firm's perception of its competitive position has a strong influence on its bid price. Its bid price is apt to be higher if the firm is the system developer and the only one who has produced the item or has produced the item in recent years. As other firms learn to produce the item at low, moderate, or high production rates, the bid prices are lowered. Capacity and manufacturing equipment

FIGURE 4-5

COMPETITION INDEX

SYSTEM/ITEM:
CONTRACTOR:

FACTORS	WEIGHT	SCORE[1]	TOTAL
1. Perception of Competitive Position			
a. Production experience			
b. Capacity			
c. Age of facilities			
d. Area wage rates			
e. Union			
2. Anticipated Future Requirements			
a. US			
b. FMS			
c. Spinoffs			
d. Other components			
3. Economic Conditions			
a. Current			
b. Future			
4. Company Goals			
a. Immediate			
b. Long range			
5. Risk Assumption			
a. Technical risk			
b. Quality of TDP			
6. Capital Investment			
a. Dollar value required			
b. Use of GFE			
c. Type of equipment			
7. Make or Buy Considerations			
a. Sole-source subcontractors			
b. Government directed subcontractors			
8. Other			
a. Types of contracts			
b. Should cost			
c. Value engineering			
d.			
e.			
TOTAL			

1 Assign scores based on the following scale:

Extremely Strong Increasing Influence	Strong Increasing Influence	Weak Increasing Influence	Unknown or No Influence	Weak Decreasing Influence	Strong Decreasing Influence	Extremely Strong Decreasing Influence
+10	+5	+2	0	-2	-5	-1

can influence bid price. Too much excess capacity requires that overhead be allocated over a small amount of output, thus driving the bid price up. At the same time, the need to enlarge output to absorb overhead can work towards a downward adjustment in price. The age of manufacturing equipment can indicate higher costs if the equipment is inefficient or obsolete. Area wage rate differentials and union agreements also affect price. A strong union may force a higher price due to higher wages and increased costs of benefits, and may dictate uneconomical make or buy decisions. Wage rates vary throughout the country. If a firm is located in an area where wage rates are high, this tends to raise the bid price. Such factors also may increase the bid price of a competitor who perceives a competitive advantage based on his own circumstances.

2. Anticipated Future Requirements. Many firms base the bid price on quantities in excess of those basic quantities expressed in the solicitation. The greater the anticipated requirements for a given item, the lower the bid price. This includes both US requirements and FMS requirements for the item. The possibility of technological spinoffs with commercial or other Government value will lower price. The possibility of obtaining additional work on other system components will also lower price.

3. Economic Conditions. In unstable economic times, contractors are likely to include contingencies in the bid resulting in an increase in the bid price. If economic conditions in the future are generally gloomy for the country or an industry, bid pr[illegible]re apt to be lower in the hope of capturing long-term business. Conversely, if good times are ahead and an industry expects ample business, the bid price will tend to be higher.

4. Immediate and Long-Range Company Goals. The objectives of a firm often influence the bid price. The desire to maintain a certain commercial/Government product mix can have a positive or negative impact on price. A strong desire to enter a state of the art market will tend to reduce price. Future expansion plans will also influence price. Minimum return on investment objectives may increase price.

5. Risk Assumption. The amount of technical risk assumed by the contractor involved in producing an item impacts bid price. The higher degree of technical risk, the higher the price. This is closely related to the quality of the TDP. The better the TDP, the lower the ultimate price.

6. Capital Investment. The higher the capital investment involved in production of the item, the higher the price. Also, firms which use a lot of Government furnished equipment can generally charge a lower price. The type of capital investment also has a strong influence on price. If the investment is for items with a long productive life or which can be used for the production of various items, the bid price will be lower.

7. Make or Buy Considerations. If an item is largely subcontracted and the prime contractor is primarily a fabricator of various sole source subcontractor outputs, there is little potential for savings. A large number of Government directed sources have the same effect. Competition is then only for fabrication and inspection costs, overhead, G&A, and profit These costs may be less than 30% of the price of an item.

8. Other. This category includes such factors as existing types of contracts, should cost, and value engineering. The mix of fixed-price type contracts to cost-type contracts has an impact on price. Generally, the larger the number of fixed-price type contracts the more stringent the cost controls. Consequently this lower the price. Should Cost techniques are traditionally considered to result in lower prices, and a firm's history of using value engineering royalties as a substitute for profit can result in greater savings. Any other factors peculiar to a specific situation which will have a significant impact on savings due to competition should be included in this category. For comparability with the competition index for other systems it is imperative that all additional factors be completely documented.

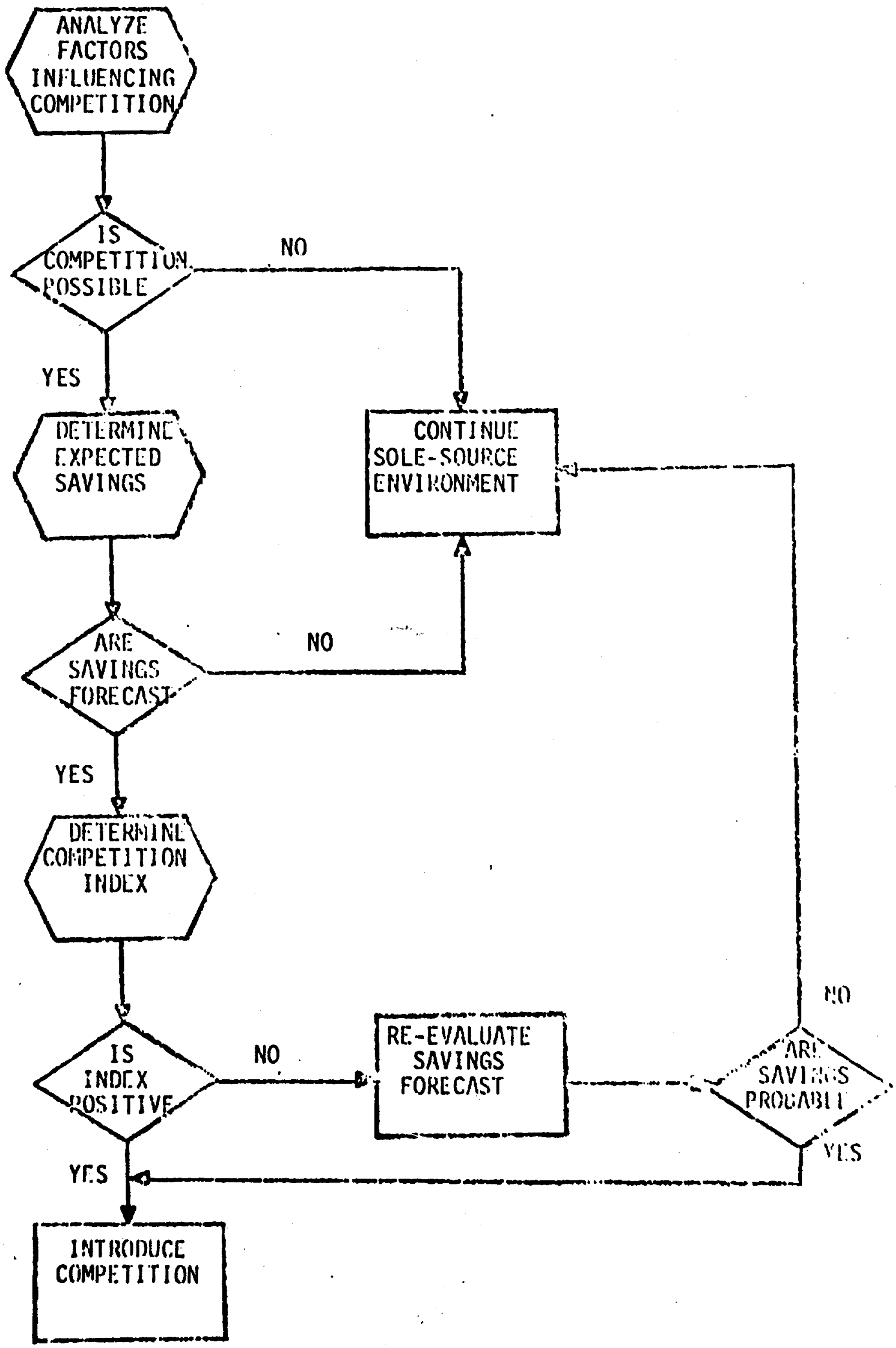
E. USE AS A FORECASTING TOOL

The forecasted savings methodology can be a valuable tool for the procurement decision maker. It provides a numerical estimate of the expected savings (or loss) from competition as well as an analysis of those qualitative factors influencing the competition. With such information the decision maker can feel confident in his decision to continue in a sole source situation or to introduce competition. As additional systems are added to the data base and refinements are made where needed, the applicability will be broadened.

To gain full advantage of the forecasted savings methodology, it must be properly applied. Figure 4-6 graphically depicts the procedure and decision points in a typical application. If an analysis of the factors influencing the competition show that competition is possible, a forecast of the expected savings should be made. If the analysis shows that competition is not possible, the decision should be to continue in a sole source environment. A competition index should be determined if a positive savings is forecast. If a loss is

FIGURE 4-6

PROCEDURE FOR APPLYING THE
FORECASTED SAVINGS METHODOLOGY



forecast, the decision should be to continue in a sole-source situation. If the competition index is positive, competition should be introduced. If it is negative, a re-evaluation should be made of the savings forecast paying close attention to the sensitive variables. When a positive savings is still forecast after the re-evaluation, but the competition index remains negative, the decision is not automatic, but becomes a matter of judgement as to the probability of a savings based upon the relative strength of the quantitative and qualitative measurements.

One caution is noted here that should be remembered when applying this methodology and resolving the above conflict. The data base upon which the regression model was structured was not randomly composed but consists primarily of those systems where a conscious decision was made to compete, for whatever reasons; and a savings was probably expected and usually obtained. The numerical savings forecast using this data base will therefore be biased somewhat in favor of competition. This does not present a problem when the competition screen analysis, the forecasting methodology, and the competition index all favor competition. It does mean that the competition index should be given slightly more weight when a conflict between it and the savings forecast exists.

CHAPTER V

COMPETITION

A. A PERSPECTIVE OF COMPETITION

OMB Circular A-109, Major System Acquisition, continues to stress the need for competition in the Federal Government's acquisition process. The Department of Defense is responding to this emphasis and is seeking to increase competition in the production of complex, high cost weapons systems.[15]

Much has been written about competition and how it saves the Government money when introduced into weapons systems acquisition. Most of the studies claim substantial savings through reduced unit prices and attribute the reduction to competition. While this report supports the belief that savings have been made in the past and will continue to be made in the future through competition, it recognizes that competition does not always result in a savings to the Government, and that when savings do occur, not all the price reduction creating the savings is due solely to competition. A portion of the price reduction is due to contractor learning. It also recognizes the expenses incurred by the Government to obtain a competitive environment and identifies some of the problems that may be created by establishing competition.

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[15] Church, D. W., "Defense Procurement Policy Goal: Maximum Competition," Commanders Digest, Volume 20, No. 21, December 8, 1977.

Figure 5-1 illustrates the approach this study uses to recognize contractor learning. The asterisk or projected bid price is determined by extrapolating the sole source cost improvement curve to cover the competitive procurement quantities. The triangle or actual competitive bid price is the actual unit price bid by the winning contractor regardless of who wins the competition. The portion of the price reduction attributable to competition is that portion between the asterisk and triangle. A continuation of sole source contractor learning accounts for the remainder of the total price difference since it is reasonable to assume that a fixed price contract could have been negotiated with the sole source based on a continuation of the sole source learning rate.

Simply using unit price reduction as the yardstick for measuring the impact of competition can be very misleading. In addition to learning, it ignores other costs and risks that, when considered, could change what would appear to be a net savings into a net loss. Figure 5-2 further illustrates the difference in these two views of competition. It was compiled using actual cost and price data from the weapon systems reviewed by APRO. Column number three shows the percentage reduction in unit price in going from a sole source situation to the first competitive buy. Column six gives the results of exercising the estimated savings methodology which includes consideration of learning, inflation, and competition related expenses incurred throughout the entire production program in addition to hardware unit price differences. The two approaches of measuring the impact of competition produce considerably different results.

Using the price difference approach some previous studies have failed to examine post-award performance. This can be especially misleading in situations where the new contractor never delivers the item and the Government is

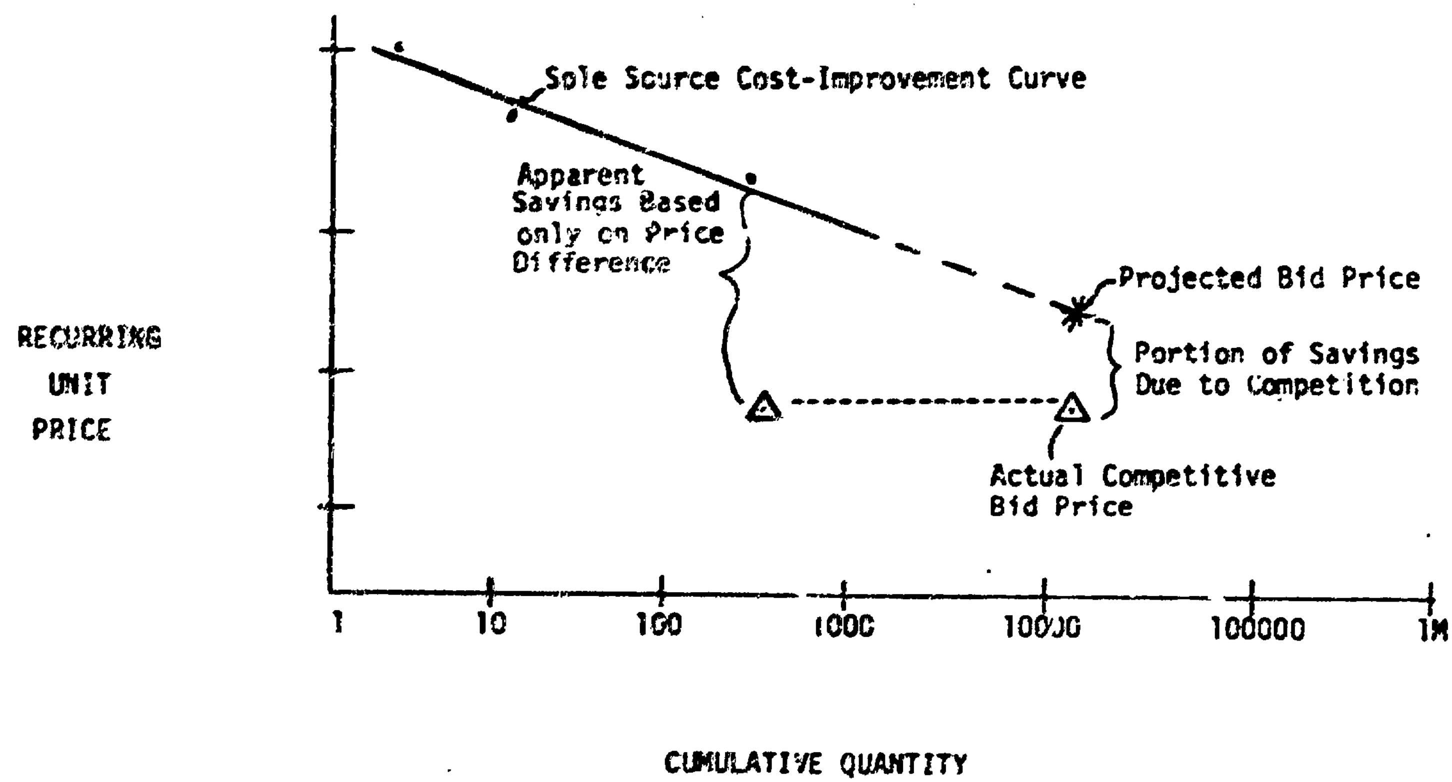

FIGURE 5-1. Technique for Estimating Savings Due to Competition.

NOTE: The apparent savings based only on price difference exceeds the actual savings due to competition primarily because it fails to consider contractor learning.

SYSTEM	SYSTEM CONTRACTORS	PRICE DIFFERENCE APPROACH 1 Pre-Comp Unit Price (72$)		2 First Comp Bid Price (72$)	3 % Price Reduction	PROJECTED LEARNING APPROACH 4 Sole-Source L.C. Rate	5 Sole-Source Proj. Price (72$)	6 Est. % Savings
TOW Missile	Hughes, Chrysler	3424. 3276.	SC SC	2095. 2652	38.8	est 87. avg	2412	8.5
TOW Launcher	Hughes Emerson	41651. --		17054 15940.	61.7	93. avg	27090	30.2
DRAGON Round	McDonnell-Douglas Raytheon	2104. 2263.	SC SC	1252. 1227.	41.7	85.	1883.	2.7
DRAGON Tracker	McDonnell-Douglas Kollsman	6755. 6732.	SC SC	3729. 3420.	49.4	88.	6763.	12.0
SHILLELAGH	Philco-Ford Martin-Marietta	3359. 3235.	SC SC	2049. 2432. est.	33.0	85.	2882.	5.9
FAAR Radar	Sanders Sperry[1]	131222. --		169700. 59805.	52.7	88. est	241748.	16.6
FAAR TADDS	Sanders Sperry[1]	4838. --		3582. 2714.	43.9	88. est	3941.	18.2
AN/PRC-77	RCA Electrospace	1179. --		691. 548.	53.5	91.	1014	34.8
AN/ARC-131	Magnavox Def. Electronics[2]	3121. --		4048. 2236	28.4	99.	3200.	(2.1)
URM-98	Admiral Monmouth Ind.[2]	10413. --		6258. 5920.	43.1	85. est	9807.	3.0
PP 4763/GRC	Christie Elect. Def. Electronics[2]	1232. --		N/A 516.	58.1	95. est	1099. est.	.3
					AVG 45.8			AVG 11.8

SC - Split competition
1 - Contractor lost money
2 - Contractor never delivered

FIGURE 5-2. Comparison of Two Approaches for Measuring Savings From Competition.

forced to return to the sole source in order to obtain the item. If the three situations where this occurred in the present study (ARC-131, UPM-98 and PP 4763) are excluded from the data base the average savings under the price difference approach would be 46.8%. Under the project learning approach the average savings would be 16.1%. The costs of these aborted procurements have been taken into consideration in the ESM calculations.

B. COMPETITION BENEFITS

The benefits of competition are numerous. Obviously, reduced weapons system unit price is the major benefit to be gained by the Government from engendering competition. As shown in Figure 6-1, the average savings for 16 weapon systems was 10.8%. Total dollar savings was $310 million, but benefits other than cost are also to be expected from competition.

One such benefit is the knowledge that the competitive contract price is at or near a fair and reasonable minimum without the necessity of conducting expensive Should Cost studies or dueling with the contractor over a negotiation table. The competitive environment tends to accomplish this for the Government without the large cost and manpower outlays of the Should Cost approach.

Another benefit is an expanded production base from multiple producers. In the event a large quantity was urgently needed, two producers could be used to meet the requirement when a single producer lacked the capacity.

A proven TDP is yet another benefit of competition. The fact that a second contractor produces the system from the TDP and not sole source internal drawings or proprietary information tends to verify the integrity of the TDP for other purposes such as maintenance and repair.

Still another benefit is the inherent appeal of competition. It allows every competent producer a chance to bid on the item. No sole source justification is needed for Congress or the public when competition is introduced, and the aura of "fair play and a good price" is maintained.

C. <u>COMPETITION COSTS AND RISKS</u>

The benefits of competition can be significant, but they are not to be gained without some cost or risk. As shown in Figure 6-1, five of the sixteen systems analyzed actually lost money when competition was introduced.

Generally, a Project Manager has an easier and happier life if he stays with the system developer throughout the production of his item. The system developer has amassed the huge amount of knowledge required for successful production of the item. This knowledge is not easily transferred to a new producer. In most instances, a new producer will experience production difficulties which may lead to delays in delivery and/or increased costs.

Over the years of development and early production, the Project Manager and system developer should have developed a healthy working relationship which can be jeopardized when competition is introduced regardless of the outcome of the competition. The system developer also becomes imbibed with a sense of pride in and responsibility for the item. This can be lost when production is transferred to a new producer where it may be considered "just another job."

To make the decision to introduce competition requires a comparison of the benefits as discussed previously with the expected costs and risks associated with establishing a competitive environment. Certain costs are obvious and well defined such as the amount paid to a prime contractor to support the education of a second source. Other costs are not as obvious or as easily quantified but may be properly charged as a cost of competition depending upon the circumstances. Such a situation is the educational buy for a second source.

The educational buy is usually a small quantity of hardware used to verify that a contractor's product is technically acceptable. If these units are tested to destruction, their cost should be charged against the savings expected from competition. If the units are tested and then added to the inventory to reduce the remaining quantity needed to meet program requirements, no charge should be made.

The costs of stretching the program production schedule to accomodate competition are properly chargeable against expected savings, but they can be very difficult to identify and quantify. Possible production breaks with resulting cost changes and lost learning are debits against expected savings. The respective quantities procured from two contractors in a split-buy situation may force the contractors to produce at some other than their most efficient production rate. Other things being equal, one contractor should be able to produce the total quantity at a lower average unit price.

Government in-house resources required to manage and support competitive environments are generally larger than for a sole source environment, sometimes substantially larger. One document estimated the additional cost exceeded $1 million in a $35 million program.[16] These costs are also chargeable against expected savings, even though this study did not include them because of time constraints.

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[16] "FAAR Cost Study." US Army Missile Command, Redstone Arsenal, Alabama 35809. 4 January 1973. (Confidential).

Even more elusive than the above costs are the risks of additional costs or problems caused by other factors influencing competition. The costs associated with these factors are not easily forecast but are very real expenses to the Government when they occur. An example of such a cost is the unrecouped progress payments made to a contractor that goes bankrupt while attempting to produce the item. Another is the schedule slippage caused in some other program when the item being procured competitively is not available and is Government Furnished Property for that program.

The possibility of a contractor "throwing darts" in arriving at a bid price is another risk present with competition. This buy-in possibility always exists. Sometimes it is intentional; at other times it occurs through ignorance of system requirements or problems. The situation usually creates numerous problems in the Government/contractor relationship which many times must be solved in court. A large disparity between the bid price of the winning contractor and that of the system developer is one early indicator of such a possibility.

Another risk always present in competition is an inadequate TDP. Although the package is reviewed and approved by the Government prior to competition, numerous production or design problems can occur. These problems then become vehicles for the second contractor to gain additional funds. The sole source contractor (developer) does not have such an "easy out" with a bad TDP since they have a vested interest in it and may retain some sense of responsibility for it.

Product quality can be affected adversely when competition forces contractors to lower their costs as much as possible. Where possible, a contractor may substitute materials or subcomponents of marginal quality which result in higher risk of problems in the field. A new vendor offering a lower price may be selected for a critical, expensive subcomponent. If the item does not fully meet specifications, a waiver may be needed to meet the delivery schedule. Yet specifications must be adhered to religously if we are to insure interchangeability of parts and compatibility between items produced by different manufacturers.

Another very real risk is the decrease in troop readiness when deployment of an item is delayed due to delinquent deliveries or no deliveries at all from a new producer.

The costs of competition and risks of additional costs can turn what would have been a net savings into a net loss for the Government. Although these costs and risks may not be easily measured or forecast, their existence must be recognized, and they must be analyzed, as part of the decision to go competitive. This is precisely the purpose of this study effort - to provide the techniques necessary to analyze the costs, benefits and risks involved in competition. It is submitted that, given the state of the art in cost analysis, the methodologies provided here are the best available for assessing and forecasting the effects of competition in weapons systems production. Implementation of the study recommendations will insure effective use of these techniques

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS.

The savings achieved by introducing competition into the procurement of weapon systems can be reasonably estimated. The estimated savings methodology (ESM) developed for this purpose considers inflation, contractor learning and competition related expenses in addition to the differences in recurring unit hardware price. It has been exercised on 16 different missile or electronics systems. Figure 6-1 summarizes the results of those applications. The dollar savings column is in millions of FY 72 dollars.

FIGURE 6-1

SUMMARY OF ESM APPLICATIONS

SYSTEM	PERCENT SAVINGS (LOSS)	DOLLAR SAVINGS (LOSS)
TOW Missile	8.5	61.3
TOW Launcher	30.2	83.5
DRAGON Round	2.7	8.0
DRAGON Tracker	12.0	12.2
SHILLELAGH Missile	5.9	18.3
FAAR Radar	16.6	4.8
FAAR TADDS	18.2	2.0
PRC-77 Radio	34.8	52.6
ARC-131 Radio	(2.1)	(.6)
UPM-98 Test Set	3.0	.08
SHRIKE Missile*	51.0	103.2
SIDEWINDER Missiles*		
AIM-9B GCG	(4.0)	(6.7)
AIM-9D/G GCG	(2.7)	(1.9)
Standard Missile*	(3.9)	(11.8)
BULLPUP AGM-12B Missile*	16.0	38.3
MARK 46 Torpedo*	(13.2)	(52.9)
AVG =	10.8	

*System analyzed by Tecolote Research, Inc.

Savings were generally obtained from introducing competition. Using the ESM, the average percent savings for the 16 systems reviewed was **10.8%.** This is less than the amount of savings historically claimed. Five of the 16 systems show a loss.

These results reflect the quality of the available cost data, since the ESM is only as good as the data available to support it. If the input data is reliable and accurate, the ESM provides a reliable estimate of savings achieved. Whenever the cost data has shortcomings, assumptions are necessary to complete the ESM. The estimates given in Figure 6-1 are believed to be the most reliable estimates available from the current data base; even though there was considerable variation in the data quality among the systems.

The current formats used to collect cost and quantity data for cost-improvement curve construction can be improved upon. Specifically, the DD Form 1921-1 and DD Form 1921-2 need to be structured so they are compatible with each other and contract information and do not need to be supplemented with data from other sources. Although the concept of learning does not apply equally well to all cost factors reported on the forms, valid cost information needs to be collected from which cost-improvement curves can be constructed that capture gross contractor learning based upon recurring hardware unit cost. Since the ESM is highly sensitive to the sole source contractor's cost-improvement curve, it is imperative that the cost data be as realistic as possible.

The data base established during the review and analysis of the systems listed in Figure 6-1 has allowed the development of the forecasted savings methodology (FSM). The FSM provides an estimate of the expected savings or loss from introducing competition as well as an analysis of the qualitative factors influencing competition. It can be a useful tool for the Comptroller of the Army in budgeting for future systems similar to those that comprise the data base. The FSM can also be used to provide an independent estimate of expected weapon system cost for comparison with the Project Manager's estimate. It is relatively simple to apply and includes an analysis of both the qualitative and quantitative factors influencing the competition.

Savings are not to be obtained without some expense and risk assumption associated with introducing competition. The Government benefits financially from competition only if net savings are realized after all competition related expenses are accounted for. These expenses and risks may not be easily measured, but their existence must be recognized and analyzed as part of the decision to go competitive. To do otherwise is to blindly accept general policy at the risk of incurring a loss that could have been avoided.

B. RECOMMENDATIONS

The estimated savings methodology and forecasted savings methodology have been developed as tools to assist in determining the impact of competition. They provide a means of addressing the factors that influence competition and forecasting the outcome of introducing a competitive situation. The following recommendations are offered to make the most effective use of these methodologies.

1. Adopt the estimated savings methodology (ESM) as the Comptroller of the Army approved procedure to estimate savings achieved from competition. It is relatively simple to apply and theoretically sound.

2. Test the forecasted savings methodology (FSM) on a system meeting the required competition structure to verify its applicability and accuracy. Two possible test systems are the Navy's Sparrow 7F and Standard Missile Two missile systems.

3. If the FSM is verified through testing, adopt the forecasted savings methodology (FSM) as the Comptroller of the Army approved procedure for independently forecasting savings expected from competition. This estimate is to be compared with the Program Manager's estimate. The FSM includes an analysis of both the qualitative and quantitative factors influencing competition.

4. Also, if the FSM is verified through testing, adopt the forecasted savings methodology as the Comptroller of the Army approved procedure to forecast budgetary requirements for future missile and electronics systems being considered for competition. It provides the best available prediction of future system cost and is based upon an in-depth analysis of 16 missile and electronics systems.

5. Revise the formats of DD Form 1921-1 and 1921-2 to be compatible with each other and provide for the construction of realistic cost-improvement curves. It may be that one form that captures the learning achieved in recurring hardware unit cost will be sufficient.

6. Expand the data base to include additional weapon systems or items that meet the criteria of sole source production followed by one or more competitive buys. The regression model in the FSM is useful for forecasting

savings for similar systems; (i.e., missiles and electronics) but the general methodology applies to all weapon systems. If a data base can be established for munitions or aircraft, for example, the methodology can be adapted to apply to those systems as well.

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APPENDIX A

PRICE INDICES FOR MISSILE PROCUREMENT

FY	INDEX
64	.791
65	.810
66	.850
67	.856
68	[illegible]
69	.910
70	.923
71	.956
72	1.000
73	1.024
74	1.146
75	1.200
76	1.339
77	1.432
78	1.601
79	1.700
80	1.792
81	1.890
82	1.992
83	2.100

NOTE: Indices for FY 64 - FY 75 are compound indices from the "Historical Inflation Indices for MICOM" dated 15 Oct 75. Indices for FY 76 and FY 77 are estimates of actual escalation. Indices for FY 78 - FY 83 are composite indices based on the indices provided in a memo from the Budget Review Committee (BRC Memo 78-148), Office of the Comptroller of the Army, dated 22 Aug 77.

APPENDIX B

PRICE INDICES FOR ELECTRONICS PROCUREMENT

FY	INDEX
67	.831
68	.8599
69	.8882
70	.9173
71	.9533
72	1.0000
73	1.0351
74	1.0721
75	1.1924
76	1.2857
77	1.3945
78	1.4744
79	1.5476
80	1.6154
81	1.6801
82	1.7475
83	1.8175
84	1.890[illegible]

SOURCE: "Inflation/Price Escalation Instructions," ECOM Pamphlet 11-1 C-4, Volume 7. Electronics Command, Fort Monmouth, New Jersey.

STUDY TEAM COMPOSITION (U)

This study was conducted under the direction of Paul F. Arvis, Ph. D., Director, U. S. Army Procurement Research Office, U. S. Army Logistics Management Center (ALMC). Mr. E. T. Clark, Office of the Comptroller of the Army, Directorate of Cost Analysis, served as Chairman of the Study Advisory Group. Members of the study team were:

Edward T. Lovett, Project Officer, B. A. in Psychology, Villanova University, 1969; M. S. in Contract and Procurement Management, Florida Institute of Technology, 1974; Certified Professional Contracts Manager; Procurement Analyst, U. S. Army Procurement Research Office, ALMC. Prior to joining the U. S. Army Procurement Research Office, Mr. Lovett was a Logistics Management Specialist and a Commodity Program Management Specialist at Headquarters, U. S. Army Materiel Development and Readiness Command and a Contract Specialist with the U. S. Army Electronic Command at Fort Monmouth. In addition to his research assignment, Mr. Lovett is an Adjunct Professor of Procurement at the graduate level for a local university.

Monte G. Norton, P.E., B. S. in Industrial Engineering, North Dakota State University, 1969; M. E. Industrial Engineering, Texas A&M University 1970; Industrial Engineer, U. S. Army Procurement Research Office, ALMC. Prior to joining the U. S. Army Procurement Research Office, Mr. Norton was an Operations Research Analyst with the Defense Logistics Studies Information Exchange (DLSIE). Before that, Mr. Norton was a General Engineer with the Safeguard System Command, Alabama, and has been a Government subcontractor.

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13. ABSTRACT

BACKGROUND. The Department of Defense has had no firm basis for deciding when to introduce competition, or if competition should be introduced. When the value of competition cannot be measured with a reasonable degree of confidence, defense of budgetary estimates and the development of a acquisition strategy is difficult, if not impossible. (U). STUDY APPROACH. The approach taken included a thorough investigation of the procurement histories of sixteen items originally produced on a sole source basis and later competed; the identification and analysis of factors explaining savings due to competition, and the synthesis of these factors into workable methodologies for estimating net savings on historical systems and forecasting expected savings for future systems. A data base is developed. SUMMARY AND CONCLUSIONS. The savings achieved by introducing competition into the production of weapons systems can be reasonably estimated. Of the sixteen items analyzed, five showed a loss due to competition. Savings for the sixteen items averaged 10.8 percent. The forecasted savings methodology (FSM), which was developed from the analysis of the sixteen systems, is a useful tool which provides an estimate of the expected savings, or loss, from introducing competition as well as an analysis of the qualitative factors influencing competition. (U).

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